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COMMERCIAL FISHERIES Review

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National
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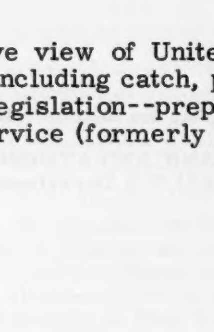
COVER: Deck load of tuna caught off New England during NMFS explorations.

COMMERCIAL FISHERIES

Review

A comprehensive view of United States and foreign fishing industries--including catch, processing, marketing, research, and legislation--prepared by the National Marine Fisheries Service (formerly Bureau of Commercial Fisheries).



Fishermen's Memorial
Gloucester, Mass.

Editor: Edward Edelsberg

Production: Jean Zalevsky
Alma Greene

Throughout this book, the initials NMFS stand for the NATIONAL MARINE FISHERIES SERVICE, part of NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA), U.S. Department of Commerce.

Address correspondence and requests to: Commercial Fisheries Review, 1801 North Moore Street, Room 200, Arlington, Va. 22209. Telephone: Area Code 703 - 557-9066.

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CONTENTS

The 66-foot seine netter, M/V 'Skanderborg', operates in North Sea.
Vessel is owned by Boston Deep Sea Fisheries of Hull, England.

OECD MEMBERS REPORT 1970 WAS GOOD YEAR

The members of the Organization for Economic Cooperation and Development (OECD) have reported that their catches of fish for human food remained steady in 1970 and that the year was "highly satisfactory from the economic viewpoint." This information is contained in the fourth review produced by the Committee for Fisheries of OECD.

• Overall, the volume of fish landed for human food remained steady--but it was more expensive to catch them. This was so despite the continued rise in catching efficiency. Excepting isolated cases, the upward trend in market returns noted in 1969 continued significantly through 1970.

• The unsettled economies of some countries affected adversely the conduct of fisheries at governmental and industrial levels. But the adverse effect was limited to these countries--"and did not prevent 1970 from being generally described as highly satisfactory from the economic viewpoint."

• There had been fears of sharp drops in the total yields of certain major fishing areas, but these did not occur. However, the North Atlantic continues to cause concern. More attention was paid to the nutritional purity of fish as food and to its environment. A few reports adversely affected demand, but these occurred too late in 1970 to be noticeable.

INTERNATIONAL COOPERATION

• There was growing awareness of danger to fish stocks from pollution--oil, unwanted minerals, waste matter (radioactive or otherwise poisonous), or other origins. Man's use or misuse of the ocean's wealth was the theme of several international forums.

• Conservation regulations continued to emerge from the North East Atlantic Fisheries Commission (NEAFC), International Commission for North West Atlantic Fisheries (ICNAF), and the North Pacific bodies for salmon and halibut. These included mesh-size control (NEAFC), closed seasons (ICNAF), quota and time limitations in Pacific, and restrictions on fishing specific stocks, such as the Atlanto-Scandian herring. International policing on the high seas to support the North Atlantic measures was in force.

• Significant to the signers and nations trading with them was the agreement towards the end of 1970 by the six members of the European Economic Community (EEC) on a common fisheries policy scheduled to go into effect early in 1971.

• In 1969, the European Free Trade Association (EFTA) agreed on minimum prices for frozen fillets imported into the United Kingdom. The prices became effective on January 1, 1970; increases for 1971 were agreed on in October 1970. Canadian and Nordic producers of frozen fillets continued to work together in facing marketing problems.

GOVERNMENT INTERVENTION

In 1970, there was no sharp drop in government involvement, but the cost to the taxpayer probably was less. Because of improved returns, operational subsidies were less. Aid to shipbuilding was down somewhat. Price-support schemes were used less often.

But government machinery remained ready for emergencies.

Non-financial aid is increasing--from improvement of fishing harbors to the design of retail fish shops to technological developments in fish finding, catch handling, unloading, product research, etc.

Such services are becoming more expensive and more sophisticated. Industry's chances "of ever being able to meet the bill become more remote. The best that can be expected is that realistic contributions be made by those receiving the direct benefit."

The members of OECD are: Austria, Belgium, Canada, Denmark, Finland, France, the Federal Republic of Germany, Greece, Iceland, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

CATCHING POWER

The history of fishing industry reveals that two successive "reasonably good" years stimulated new building. But the current fleet renewal is comparatively slow, especially for larger vessels. Only in one or two countries building for others--France--is there "remarkable expansion" in launchings.

The inactivity is attributable partly to high cost of building and equipping deep-sea fishing craft. Construction costs rose in the Netherlands, and these may be fairly typical. Using 1960 as base year, indices from 1967 were:

1967	- 143
1968	- 152
1969	- 164
1970	- 178

The cost of building a fishing vessel probably doubled in about 12 years, while fish prices at the landing stage advanced slowly. That explains reluctance to order larger-type fishing craft.

For smaller vessels, 50 to 100 G.R.T., several countries reported satisfactory intakes of new vessels. The numbers of inshore boats in the lowest category fell agin in 1970.

In 1970, the deep-sea fleets of OECD members decreased numerically and in overall gross tonnage; the other categories became more powerful.

PEOPLE

Again, the number of people making their living by fishing fell. There was more action by governments to prevent further reduction. The governments set up subsidized fishing schools or courses of instruction with subsistence allowances to students.

The OECD report states that "it has not been uncommon" for fishing countries to record a 25% drop in full-time fishermen over a 10-year period. "There is no need to stress the consequences of a further fall of similar magnitude before the end of this decade."

Compared with labor disputes in other industries, there were few in fishing. But those that did develop among crews and shoreworkers caused much local disruption that lasted months.

CATCH

The slight drop in overall catch recorded in 1969 was more than recovered in 1970. The reason was the higher landings of fish for reduction to meal and oil. The volume of fish for direct human use remained almost the same. By species and country, however, there were some important changes.

For those countries relying to a great extent on the waters around the British Isles (ICES Regions IV, VI and VII) for their food fish (Belgium, Netherlands, Sweden, etc.), nearly all landed less in 1970 than in 1969. This reflected the deterioration in yields of certain groundfish: sole and North Sea herring. By contrast, herring stocks in the western part of these waters improved. This allowed higher returns for Ireland and the United Kingdom.

The coastal areas of Norway and Iceland provided good yields, particularly of cod, for their fleets. Vessels of other nations operating near Iceland also enjoyed good fishing; in some cases, catches were over 25% higher than in 1969.

But other northern sea areas, including the offshore Norwegian grounds, were not quite so productive as in preceding years. This is not noticeable in combined landings because there was more transfer of effort from the North West Atlantic and this kept up the landed weight.

Yields in the North West Atlantic were no better in 1970 than in 1969. For some species, there were sharp drops--apart from losses resulting from temporary closure of Georges Bank.

For the whole North Atlantic, the cod catch was about the same in 1970 as in 1969. Preliminary figures indicate a drop not exceeding 4%. Main reductions occurred in the catches of Canada, Germany, Portugal, Spain, and the United Kingdom. These averaged about 10% in each case. The deficit could not be made up by the better landings in Iceland and Norway, the latter's at record level.

There was a general scarcity of certain qualities of herring for human use. This created good demand and encouraged more intensified fishing and produced higher landings in Ireland, Netherlands, Norway, and the

United Kingdom. However, scarcity in the North Sea continues; so does the poor state of the Atlanto-Scandian stock.

The 1969 level of raw material for reduction was maintained in 1970. Shortfalls of 44,000 tons in Canada and 29,000 tons in Denmark were more than made good by Iceland (up 18,500 tons), Norway (up 418,000 tons), and Sweden (up 60,000 tons).

Again there were striking changes in species composition. For the main OECD producers, these were important changes:

	1967	1968	1969	1970
	. . . . ('000 Tons)			
Denmark:				
Gadidae (e.g. haddock)	72	119	465	261
Norway Pout	183	428	68	158
Herring	273	369	273	228
Sandeel	208	201	114	191
TOTAL	787	1,167	997	1,066
Iceland:				
Herring	376	56	3	1
Capelin	97	77	169	190
TOTAL (incl. demersal)	476	137	178	199
Norway:				
Capelin	403	522	679	1,301
Norway Pout	15	71	80	116
Herring	1,097	612	140	217
Mackerel	841	745	674	248
TOTAL	2,410	1,983	1,601	1,934

In 1965 and 1966, Iceland used about 670,000 tons of herring, and Norway about 1,000,000 tons each year. Canada's raw material now is predominantly Atlantic herring; production rose from 13,000 tons of meal in 1965 to 92,200 tons in 1969. In the U.S., more than half the meal production long has come from menhaden in varying amounts.

The Nordic countries combined have been catching around 3,000,000 tons a year for reduction; capelin took precedence over herring and mackerel in 1969 and 1970. Catch restrictions have been imposed from time to time for industrial or conservation reasons. In 1970, Norway introduced a catch quota on mackerel. This led to fishing stoppages in the summer and autumn. Denmark's 1970 production was affected by strikes.

SHELLFISH

Shellfish (crustaceans and molluscs) have growing value to almost every country. Generalizations on the developments in catching or harvesting them are difficult.

Canada's lobster catch, although regulated, was more valuable than any species, including the much-improved salmon returns.

The U.S. shrimp catch of about 112,000 tons (U.S. 1970 consumption was around 200,000 tons) was a record. It was worth about a quarter of the total and over twice as much as any other species. Crabs, oysters, lobsters, clams, and scallops were all among the 10 most valuable U.S. species.

France's landings of shellfish (excluding highly prized oyster production) was 20% of total value of all landings; in the United Kingdom, it was about 10%.

Because of wide differences in character, each fishery has to be treated separately. In 1970, higher landings on the Maine coast and Alaska were mainly responsible for record U.S. shrimp landings. This allowed exports of fresh and frozen shrimps, mainly to Europe, to be more than tripled from 1967 to 15,000 tons in 1969. The Alaskan king crab fishery again was low, but the weight shortage was partly made good by other, less-appreciated, types, Dungeness and Snow; so, altogether, about 60,000 tons of crabs were landed.

The king crab catch rose from 65,000-ton level in 1957/59 to 73,000 tons in 1966. It fell to 22,600 tons in 1970. Besides closed seasons, Alaska imposes a catch quota. Japanese factory ships fishing king and snow crabs are limited by quotas set by Japan and U.S. An unusual development in 1970 was price drop in the U.S. and in Japan despite further drop in king crab catch.

In a manner similar to the Nordic countries' switch to other species to offset the dwindling herring landings, Alaska gave more attention after 1966 to dungeness and snow crabs; landings rose significantly from a

combined 13,100 tons in 1965 to 32,700 tons in 1970. In 1965-1970, too, Alaska's shrimp production rose from 5,200 tons to 23,600 tons.

The Nordic and Alaskan examples illustrate that much of catching power for a specific purpose can be transferred. Seeking alternatives, European herring vessels have gone to the North West Atlantic, and the Norwegian flotilla to the Central Atlantic, both for reduction.

RETURNS

The general price recovery in 1969 was welcomed after two years of depressed demand. In 1970, the upward trend continued. Only rarely were individual countries unable to report better gross returns. Particularly notable improvements occurred in the Nordic countries (excluding Finland), the United Kingdom, and the U.S.

The improvement resulted from the maintenance of food-fish landings at 1969 level, higher landings of industrial fish, and better overall average prices.

Among the food fish, a few species did not conform to market requirements and had a dampening effect: the occasionally heavy landings of North Sea small haddocks. However, where this happened, the leeway was regained by higher prices for other kinds. One was cod, a staple of many fisheries of Atlantic-bordering OECD members. Cod prices increased as high as 30% in the United Kingdom. Steadily rising prices for blocks of cod fillets in the U.S. produced better returns to cod fishermen of Canada, Iceland, Norway and, to lesser extent, Denmark and Greenland.

MARKETING

In 1970, as in 1969, there was more international trade in fishery products and value rose 15%. Reporting rises in value of a third or more in their exports were the Faroes, Finland, Ireland, Iceland, Spain, and the United Kingdom.

Imports by Belgium, Denmark, France, Finland, Germany, and Sweden rose by about 20% in value. Only in Portugal was the value of exports or imports less than in 1969.

In the U.S., major importing country, the value of fish imports set record of \$962 million. This was nearly 14% above 1969 despite drop in fish meal imports of about 100,000 tons, or one third.

Usually, the higher values resulted from rising prices. The price level has caused some apprehension about its possible effect on demand. But the higher prices did not apply to all produce. Canned fish was on 1969 level, partly because of species composition.

Certain factors were influential in producing the higher prevailing prices. On supply side, there were occasional shortfalls in domestic production of raw material for some processing industries, or particular outlets, in countries that are both major consumers and producers. In Germany, for example, there was shortage of home-produced herring for makers of semipreserves, and not enough wet fish; lower cod landings by British trawlers; reduced sole catch by Dutch fleet. Although such reductions are made good by imports, the price of home-caught produce is likely to predominate. Also, price is likely to be pushed higher before external suppliers are used. The latter benefit from seller's market.

DEMAND

In 1970, sales promotion was intensified. This should stimulate both the domestic fisheries and imports of sponsoring countries because none of them is self-sufficient in fishing.

In the U.S., there are upward trends in the quantity and price of imported frozen blocks of fish fillets. Demand for cod fillets is "very strong" for two reasons: to meet the growing offtake for raw material for fish sticks and steaks; and to serve the spreading chains of fish-and-chip shops. So more pressure has been exerted on a supply that has its limitations. It could be a primary reason for the rising price curve in North Atlantic countries.

One event in 1970 is the type that could hurt the industry. In the U.S., quantities of canned tuna were withdrawn from sale because of excessive mercury content. Other countries followed. The mass media covered the subject. The timing was such that no detrimental effect on sales of tuna or other fish was noticeable before the end of 1970.

FORM IN WHICH CATCH SOLD

At national level, the amount sold merely chilled by ice continues to fall off slowly. But it still accounts, by far, for the highest proportion of the catch. Freezing is used increasingly. Curing and, to a lesser extent, canning are declining.

In international trade, in value, all forms for human consumption improved but particularly fresh and frozen (together) and shellfish products.

(a) Fresh

The trade in fresh fish expanded to meet shortages. Germany received direct landings from Icelandic vessels, the United Kingdom, through Denmark, and from East Europe. The Netherlands' search for sole led to consignments being sent overland from Britain's west coast.

This trade probably is more vulnerable than less perishable commodities to hindrances to commerce between countries. In 1970, there was a further lessening in the official trade restrictions, but industrially imposed obstacles remained strong.

(b) Frozen

The proportion of products in frozen form traded internationally grows. For principal producers, frozen fish was a much more valuable export than in 1969. Denmark and the Faroes together recorded an increase of about 30%. Iceland's rose 45% and Norway's 16%.

Imports of frozen fish into the United Kingdom rose about 25%. Frozen fillets from her EFTA partners were subject to minimum prices. In the U.S., imports of frozen fish blocks, mainly for fish sticks and portions, rose only about 2%; only Iceland among the principal suppliers improved (by more than a third) on 1969 figure. In value, the rise was much more substantial.

In 1970, U.S. imports of fresh or frozen fillets of all species were 270,000 tons--9% above 1969, and equal roughly to 750,000 tons live weight.

(c) Cured

There was expansion overall in trade volume of cured fish; however, this hides opposing movements.

In Norway, the rise for all types of cured fish was about 20%. Wet salted fish rose from 12,000 tons to 20,000 tons (75%); dry salted went from 47,000 tons to 52,000 tons (11%) and stockfish fell from 20,000 tons to 18,000 tons (minus 10%). This means the end of the Nigerian war has not led to the expected restoration of demand for stockfish; in fact, the Faroes export of dried cod stopped altogether. Canadian exports fell in value and were confined more than before to North America and the Caribbean.

Imports of cured fish by France and Germany increased considerably in value: 37% and 23%.

(d) Canning

To a great extent, international trade in canned fish is confined to OECD members. It is particularly important to fisheries of Canada, Norway, Spain, Portugal, Germany, and U.S. Between 1969 and 1970, there was little change in overall trade. Slightly more (3-4%) was exported, while imports fell about 2 to 3%. In view of higher production costs in most countries and generally higher prices for raw material, herring in Germany, sardines in Spain, etc., the total value remained steady. Smaller quantities were bought by the two main importers--the United Kingdom (-17%) and U.S. (-4%); exports from Norway (+11%) and Spain (+32%) were above 1969.

On the Pacific Coast of the U.S. and Canada, fish canning is centered on tuna and salmon. Both species yielded very good returns in 1970. The U.S. tuna pack was a record 200,000 tons (product weight) worth \$380 million; the salmon pack, second largest in 15 years, was 85,000 tons worth \$142.7 million.

The tuna pack, rising almost continuously, has been more than doubled over 20 years. Salmon has tended to decline.

The Canadian output of salmon also was unusually high--31,000 tons against 13,700 tons in 1969.

Among other canned fish products in North America, canned sardine fell about 20% but most shellfish other than oysters (down 10%) increased. The pack of canned shrimps was a record. As with other OECD members, the U.S. production of canned pet food continued to grow; in 1970, it was worth \$105 million.

The ingredients include food other than fish, but even at 10% this remains an important outlet. It seems likely to grow.

(e) Fishmeal

The fishmeal market is largely international, so the OECD report includes nonmembers.

In 1970, aggregated fish-meal output of major producers is estimated at around 4,890,000 tons. This is a rise of 14% above 1969 and 6.5% above 1968's record. Then, production was 4,593,000 tons. Around 35% (1969: 39%) of this production was OECD produced; the remaining 65% (1969: 61%) by six others.

The latter increased production from 2,632,000 tons in 1969 to 3,193,000 tons in 1970 (up 20%). This was due to a sharp improvement in Peru's output which, in every year since 1963, has been around four times higher than any other country's. In 1970, Peru's share reached its peak: 45% of world production. Unfavorable hydrographical conditions and fishermen's strike had cut output by 27% in 1969; in 1970, production was a record 2.2 million tons.

Rough estimates put USSR production higher again--probably around 375,000 tons in 1970, No. 3 producer. Japan is second.

The other main producers outside OECD are South and South West Africa. These produced less than in 1969 due to fewer pilchards and government quota system. Around 303,000 tons of meal was produced in 1970, compared with 471,000 tons in 1968 peak year (down 35%).

OECD production rose from 1,525,000 tons in 1966 to around 1,695,000 tons in 1970--annual rate of around 2%. Compared with 1969, less meal was produced in 1970 in Canada (-9%), Germany (-11%), and the United Kingdom (-9%). Japan and Denmark, which account for around 30% and 10% of OECD total, showed little change. Norway's output, which fell 19% in 1968, and 24% more during 1969 to 309,000 tons, was again higher in 1970, when around 40,000 tons more were produced.

In 1970, the weighted average annual price of Peruvian meal was U.S. $196.5 f.o.b. U.S. East Coast, compared to U.S. $157.10 in 1969 (up 25%) and U.S. $130.95 in 1968. Prices generally were higher during first half: around U.S. $195 against U.S. $185 from July until December, when prices stayed around U.S. $85.

In Germany, prices for Peruvian meal declined during first quarter from U.S. $238 in January to U.S. $196 in March. Then prices stabilized at around U.S. $210 until end of 1970.

This stabilization of prices during second-half 1970 was said to be caused largely by market policy of EPCHAP, Peru's central fish-meal marketing body. It happened when there was significantly higher production. It could be, says OECD report, that by restricting sales EPCHAP avoided price collapse same as 1966/67's. Then, output of 350,000 tons higher depressed prices from U.S. $156.40 per ton in 1966 to U.S. $130.15 in 1967.

Prices for fish-meal substitute--soya bean meal--increased from U.S. $82.9 to U.S. $87.1 per ton from 1969 to 1970. This resulted from increased demand for protein additives in Europe and U.S. and despite record U.S. soya harvest of around 30.9 million tons. Prices for soya meal fluctuated widely, especially during first 6 months, but they stabilized after summer peak. However, soya meal still had a price advantage over high fish-meal prices: the ratio was 2.26 in 1970 against 1.89 in 1969; a ratio of 1.3/1.4 can be taken as normal to achieve same protein content.

The above price development further reduced trade in fish meal. In 1968, 3.4 million tons were imported by main producer countries; it is estimated that in 1970 only 2.7 million tons were shipped following 1969 reduction to 2.8 million tons.

Significantly less was exported by Angola (-44%), Chile (-32%), South Africa (-43%), and Norway (-18%). On the other hand, Peru increased exports by around 230,000 tons--from 1.65 to 1.88 million tons in 1970. This was due to increased exports to centrally controlled countries, mainly Poland and Yugoslavia. These took around 22% of Peru's exports (1969: 15%).

OECD members imported about 18% less meal. They took 1.9 million tons in 1970, compared with 2.3 million tons in 1969, and 2.7 million tons in 1968. This decline was caused by price development and, to a large

extent, by new contract conditions imposed by EPCHAP.

According to EPCHAP conditions, the weight and quality of fish meal have to be determined at loading time. This means importers cannot claim shortage or defect on receipt. So several importers decided to take less meal from Peru. Significantly less was imported by U.S. (down 26% from 1969 and about 68% from record year 1968); the United Kingdom (minus 123,000 tons), and the Netherlands (minus 57,000 tons).

Germany again was leading importer: about 18%, or around 500,000 tons of meal entering world trade. Although imports to Germany decreased slightly (minus 7%), the high imports indicate compounders' preference for fish meal in mixed feed. It had been thought generally after law requiring a certain percentage of fish meal in feed mix was abolished in December 1969 that imports of fish meal would be cut.

Stocks of fish meal held by FEO countries at end of 1970 were estimated at 834,000 tons. These were more than double the extremely low stocks held at end of 1969, and 59% higher than 1964/69 average. Fishmeal Exporters Organization (FEO) members are: Angola, Chile, Iceland, Norway, Peru, South and South West Africa.

With exception of South and South West Africa, where much less meal was produced, stocks in all countries were above 1969 level; lower exports and higher production were responsible. Peru alone held around 660,000 tons, or 75% of total, then Norway (107,000 tons), and Chile (40,000 tons).

The OECD report states that 1971 development on fish-meal market will depend to a larger extent than before on price of fish meal vs. prices of competing food ingredients. The level of production may not be as important. Even a 10% decrease in Peruvian output would have limited effect on market because of extremely high stocks.

A highly important factor will be EPCHAP's policy. If it stipulates prices at 1969 level, around U.S. $196 f.o.b. U.S. East Coast, less meal may be imported by U.S. and Europe--especially because soya bean meal will be available as substitute.

Estimates of 1971 U.S. soya harvest indicate around 30 million tons. If such a switch resulted in higher prices for soya meal, the ratio of fish meal to soya meal favors the latter so much that even a 10-15% price rise would still favor use of soya.

If, however, Peru lowers the price, more fish meal likely will be used in some countries. Much depends on sales during closed fishing season (January to March). If global stocks fall to around 450,000-500,000 tons, this would release the pressure of inventories on prices, closed season and, possibly, bring lower selling prices.

At end of March 1971, inventories seemed below 500,000 tons and average prices in U.S. and Europe were still very high and favoring the use of competing feed ingredients. Therefore, world market prices were expected to remain at December 1970 level, although less fish meal would be used. As a result, stocks at end of 1971 could be higher than at end of 1970.

CONCLUSION

In 1970, the outstanding feature, undoubtedly, was the better returns at landing stage because of generally higher prices paid to catchers.

It is believed that higher quotations of meal prices hurt sales. A drop of 500,000 tons, over 50% of 1968 usage, in the U.S. is held mainly attributable to price factor. But for fish sold for human food, there is little evidence of consumer resistance, except for one or two isolated items of shellfish in semi-luxury class.

In some respects, says the OECD report, this is surprising because it is only the latest rise for mass consumers in industrial countries. These rises have affected fish much more than other foods. In the U.S., the overall average retail price of fish in 1970 rose 10% over 1969 (nearly double all foods) and brought index (1957/59 = 100) to 143.7. By comparison, the index for other sources of first-class protein were: meats 133.8; poultry 97.9; eggs 111. Only fresh fruit (144.5) rose about as much as fish.

The arguments explaining or justifying why fish prices are so much ahead of competing foods are: a much lower starting point, more ground covered in refining products, development of more costly preservation, etc. But the fact remains that for every dollar's worth of fish bought in 1960, the consumer was paying $1.40 in 1970, the buyer of beef $1.30.

In 1970, as in 1969 and 1968, U.S. per-capita consumption of fish rose; it was at a 17-year high.

When landings are being maintained and meeting strong demand, it might be expected that expansion, perhaps even of excessive fishing power, would result. So far, taking productive capacity as a whole, there has been no such pronounced tendency. New fishing units are being added--but more to consolidate. These additions often fall short of replacement and rest on much government help and, occasionally, on capital from other industry sectors.

Freezer-trawlers require from $4.5 million to $5.5 million, so any building is more and more confined to integrated companies. The only class of vessel that might be increasing is the one able to stay at sea for up to a week. Any proportional increase would be slight.

After some miscellaneous building in the 1960s, it seems that the size of the combined fleets has stabilized. Using the most optimistic forecasts of marine biologists, the fleets will draw on stocks likely lower than in 1970. At best, the supply will remain constant.

So the continued 1970 pressure of demand inevitably will bring higher consumer prices.

The most popular outlet, except where distance is an obstacle, is fresh fish, although frozen fish have made some inroads. The distribution chain for fresh fish is highly specialized and expensive to maintain. Although vigorous attempts have been made to make trade suitable for supermarkets, by and large it remains in specialists' hands. These specialists are becoming scarcer. Thus fresh fish would become more difficult to find and more expensive to buy. This process has been underway for years, but the 1970 experience points to fresh fish becoming still more costly food and being accepted by the public. But quality must be kept high to maintain consumer interest.

To producers of frozen foods, the attractions of fish as a raw material were its low price that allowed comparatively expensive treatment, storage, distribution, and sales promotion--but resulted in a commodity that still could be offered at acceptable price alongside other consumer packs. So far, the price of landed fish has not advanced sufficiently to prevent growth of quantities sold through retail cabinets. But displayed with other products, price factor has a greater influence on future trade than with fresh fish. As long as price for fresh fish keeps advancing, the price asked for fish to enter the freezing chain will also rise. This could be the basis for the concern expressed where, in one instance, export prices rose 25% over 1969.

The OECD summary concludes: "It could be that trading in food fish in the next few years will be maintained at a constant level as regards quantity of fish sold fresh but perhaps with some easing in the volume sold through other outlets as the price of raw material keeps rising."

COMMUNIST-BLOC SCIENTISTS FORESEE NO MAJOR CHANGE IN ICNAF COD STOCKS

No major changes in the condition of cod stocks in the area of the International Convention for the Northwest Atlantic Fisheries (ICNAF) are foreseen for 1972 by fishery biologists of the Soviet Union, East Germany, Bulgaria, Poland, and Romania. The scientists of the 5 East-European nations adhering to the Agreement of Cooperation in High-Seas Fisheries met recently in Poland. They made these predictions for 1972:

Greenland cod (ICNAF Subarea 1) will stay at 1968-69 level, with large adults (55-75 cms.) predominating.

Labrador cod (Subarea 2) will remain at 1970 level.

Newfoundland cod (Subarea 3) stocks are expected to increase because the abundant 1968 year-class will enter the fishery in 1972.

Cod Catches in ICNAF Convention Area, 1966-70

	Subarea 1	Subarea 2	Subarea 3	Subarea 4	Subarea 5	Total ICNAF Convention area
	(Metric tons)					
1970	103,994	209,801	520,094	255,703	35,387	1,124,979
1969	204,790	412,293	569,087	206,065	45,823	1,438,058
1968	381,869	449,342	732,813	247,333	49,176	1,860,533
1967	429,479	297,809	720,604	194,447	42,310	1,684,649
1966	366,126	337,877	498,665	215,254	57,255	1,477,257

Statistical area 6 was not included because cod catches there are insignificant.

FISH STOCKS IN W. MEDITERRANEAN ARE HEAVILY OVERFISHED

Fishing for Mediterranean hake, sole, red mullet, sea bream, and shrimp has increased so much in the last 10 years that catch yields have decreased seriously.

Stocks most affected are along the French, Italian, and Spanish coasts, the oldest and heaviest exploited areas. The situation along the Tunisian, Yugoslavian, and Algerian coasts is less alarming.

These were the findings of the Working Group of the General Fisheries Council of the Mediterranean at Rome meeting early in June.

Reduced Fishing Suggested

The group warned that because of present exploitation, and particularly small mesh size of nets, more fishing likely would result in even lower catches. Reduced fishing would improve stocks.

As a first step, the group urged that all nets with mesh size smaller than 40 millimeters, stretched measure, be banned.

The group will meet again in December to consider improvements in statistics on catches and fleet activities, and in research on effect of exploitation on individual stocks.

COD AND THE WEST

C.L. Sulzberger

REYKJAVIK, Iceland--Future strategy of the NATO allies depends on what agreement they can reach about catching the glistening, nutritious codfish abounding in this island's waters. Cod and haddock harvested from the neighboring sea comprise Iceland's greatest natural resource and finance its high standard of living and remarkable culture.

In the nineteen fifties, when Reykjavik extended national fishing limits out twelve miles, Britain, the main market, ignored this and there were actual armed incidents involving violators although nobody got hurt. In 1961 Britain accepted the new limits and it was agreed to send future disputes to the World Court.

Now Iceland announces it will scrap the accord and extend territorial waters out fifty miles to exclude foreign trawlers. The British flatly reject this and the West Germans go along.

As if this dispute with two allies were not enough, the new Government has also proclaimed its intention of expelling the American forces that tend and protect the NATO base here. Iceland itself is wholly unarmed so the base would be left up for grabs, although this country doesn't want to quit the alliance itself.

Finally, faced with the prospect of Britain joining, Iceland wants an arrangement with the Common Market to assure adequate fish exports. It doesn't covet associated status but a special deal comparable with that between this country and the United States on air transport.

Icelandic Airways is not a member of the International Air Transport Association (I.A.T.A.) and therefore isn't bound to its price scales. It manages to undercut I.A.T.A. planes on trans-Atlantic flights but Washington permits Icelandic planes--the only non-I.A.T.A. line--to land, although U.S. as well as foreign airlines object.

The new Government raised all these problems together by bold promises before the elections that brought it to power: to ban foreign fishermen inside a fifty-mile limit, to oust the Americans, and to stake out a deal with the Common Market. It is beginning to wonder if all these vote-getting pledges are workable.

And London and Bonn have announced they won't accept the fifty-mile limit. The British insist the 1961 agreement was ironclad. Neither London nor Bonn are going to ask the Common Market to favor Iceland just after they have been kicked in the teeth.

So there is a dispute inside NATO apart from the dispute on NATO inside Iceland. Reykjavik might find after studying all the difficulties involved that it would be wiser to renege on electoral promises and not shove the Americans out. It has already deferred that matter to the looming cod war.

Reprinted from The New York Times, Aug. 13.

"An agreement on fishing limitations has priority," Foreign Minister Einar Agustsson told me. "We will go very slowly on other questions until this is settled. I'll take my time studying the base problem. The fishing issue has much more popular support than the base issue."

He hopes to settle fishing by September 1972. In other words, the NATO base argument need not even warm up for more than a year while passion spends itself on the cod. The allies hope that as the Government familiarizes itself with the dangers involved in ending protection of the Iceland base, less drastic solutions will be suggested.

Once before, during a brief 1956 crisis that was shelved when Russia invaded Hungary, the now-dominant parties asked that "Icelanders shall themselves undertake care and maintenance of the defensive installation, other than military duties."

This is scarcely feasible. A wholly unarmed country couldn't protect the base and two hundred thousand Icelanders don't have enough trained technicians or a counterespionage apparatus. The base is directly linked to planes in the air and ships on and beneath the sea which coordinate information.

The original concept under which Iceland joined NATO in 1949--no foreign troops or bases in peacetime--is no longer workable. It is difficult to contemplate a substitute arrangement. The Denmark Strait between this country and Greenland and the Iceland-Faroes Gap are crucially important and can best be plugged from here.

But it is hoped patient diplomacy plus goodwill will eventually find compromise arrangements assuring Iceland generous fish supplies, adequate European markets, continued cheap air rates and some means of keeping an allied force to preserve the NATO base. The emotional priority of cod and haddock allows time to cool the strategic issue.

ICELAND

FAROE ISLANDS & ICELAND COOPERATE IN FROZEN-FISH EXPORTS TO U.S.

Faroese and Icelandic exporters have agreed to merge their export of frozen fish to the U.S. market to compete better with other countries. Previously, Faroese exports of quick-frozen cod and haddock fillets to the U.S. and Great Britain were handled by private importers.

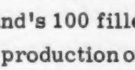
Faroese producers have felt handicapped in entering large markets even though their products have been highly regarded. Their export associations realized that a merger would help.

Coldwater Seafood Corp.

Since May 1, Faorese exports to the U.S. have been handled by the Coldwater Seafood Corp. This is a private Icelandic sales firm to the U.S. with annual sales of about 50,000 metric tons. The corporation is backed by about 70 of Iceland's 100 fillet factories. The merger adds the production of 15 Faroese fillet factories and several factory trawlers to its supply chain. Faroese exports of frozen fish quadrupled in the last two years due to improved inshore fishing and the addition of modern factory trawlers.

Iceland's U.S. Factory

The U.S. buys 80% of all frozen fish produced in Iceland. Iceland operates a large factory in Cambridge, Maryland, where the fillets are cut into portions to suit the U.S. customer. The headquarters organization in New York City maintains a wide distribution system for its ready-made products. ('Vestkysten', June 28)



UNITED KINGDOM

BRITISH FIRM TO PRODUCE PROTEIN FROM PETROLEUM

British Petroleum's plant at Grangemouth, Scotland, the world's largest for producing protein-rich yeast by hydrocarbon fermentation, will begin operations early in 1972. Toprina, the trade name for BP's protein, will be used to enrich animal foodstuffs, principally for turkeys, chickens, pigs, and for fish farming.

The first year's production already has been ordered by leading animal-feed compounders.

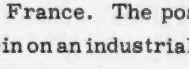
BP's 2 Plants

Grangemouth has a capacity of about 4,000 metric tons of protein a year. It is the first of two units to be operated by BP. The second, output of about 15,000 metric tons a year, is nearing completion at Lavera, near Marseilles, France. The possibility of producing protein on an industrial scale was first recognized there in 1959.

Technology has been developed for this process, which has been licensed in Japan. There, a 1,000-ton-a-year plant already has been built.

7 Years' Pilot Operation

Two pilot plants have been operating for 7 years. The product has been tested exhaustively at independent scientific institutes in Holland, and with animal-feed compounders in the U.K. and France. The protein has been blended into food and fed successfully to several generations of animals. ('South African Shipping News & Fishing Industry Review')



SALMON ARE REARED COMMERCIALLY AT BERGEN

The Norwegian firm Mowi A/S of Bergen has established after years of research that it is possible to rear salmon commercially. Similar attempts to produce salmon have been made by firms in Scotland, Canada, and East European countries without success.

The culture takes place in small bays and sounds surrounding the archipelago at Bergen. This location takes advantage of the natural flow of water from the Atlantic and the North Sea. The technique was started in 1965 by a food-processing plant named Compact.

Mowi

Mowi, established in 1969, is owned by Norsk Hydro and Compact. By mid-July 1971, Mowi had delivered 35 tons of salmon; it was expected to deliver another 40-50 tons in the following weeks. The present plant is expected to produce about 500-600 tons a year. After maximum expansion, it will be able to produce about 1,500 tons worth about US$4.2 million.

The Mowi-reared salmon do not differ from Atlantic salmon. Since salmon culture in captivity has reached the third generation, it is not yet known whether degeneration will occur in later generations. The breeding process involves crossing "tame" and "wild" salmon. Attempts to cross with Icelandic salmon also have been made.

Rearing Salmon

Production takes place around four islands. Two are equipped with fresh-water plants for culture and breeding of the fry until time when salmon normally would travel to sea. Hatching is advanced by flow of heated water through the plants. When the salmon eggs are hatched, they are placed in large fiberglass tanks containing a mixture of fresh and sea water. The fish are fed to speed growth. Normally, the smolt stage takes 2-4 years, but at Mowi 80% have reached this stage in one year. The water in these tanks is not heated, except in winter. This procedure allows the young salmon to become adjusted to sea water.

When salmon reach the smolt stage, they are moved to ocean waters. These impoundments are small sounds closed off at both ends. Pumps have been installed to supply oxygen and circulate the water in the sound during calm periods. At the final stage, the salmon weigh about 12 to 16 pounds, which is considered the most desirable size.

Annual Production

Mowi's annual production is about 1.5 million salmon fry; of these about 500,000 are used for the firm's salmon production. The firm estimates that about 300,000 fry reach the final stage. About one million fry are sold to stock rivers and fjords in Norway. ('Borsen', July 19)

CANADA

FISHERY IMPROVEMENT LOANS INCREASE

Canada's Finance Minister has reported that C$1.2 million was loaned under the Fisheries Improvement Loans Act from Jan. 1 to March 31, 1971. In the 1970 period, $861,335 was loaned.

The Government may guarantee loans granted by chartered banks and other designated lenders to fishermen for many purposes. A maximum of $25,000 may be loaned to a borrower at any one time. Loans must be secured. They are repayable over a period up to 10 years. The maximum rate of interest is determined semiannually, on April 1 and October 1. The maximum rate during the period reviewed was 8%.

The Fisheries Improvement Loan Act came into effect in Dec. 1955. From then to end of March 1971, C$13.2 million was loaned.

* * *

PACIFIC SALMON STOCKS INCREASED DURING PAST 10 YEARS

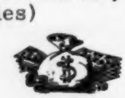
Canada's Pacific salmon stocks increased up to 24 million fish (13%) in past 10 years compared to previous decade.

Commercial fishermen caught 230 million salmon in 1961 to 1970; in 1951 to 1960, 206 million. Fishermen earned roughly C$40 million more.

Salmon Stocks Rise

Salmon stocks have increased despite industrial expansion, slides, stream abuse by loggers, and loss of spawning areas to rural development.

Contributing to increase were: 1) the $18-million resource development program of Canada's Department of Fisheries since 1950, and 2) cooperation by pulp and paper industry in setting strict pollution standards in new mills. ('Fisheries News', Canada's Department of Fisheries)



LATIN AMERICA

MEXICO

1970 CATCH ROSE 10% FROM 1969

In 1970, Mexico's fish industry reversed its downward trend: its 255,840 metric tons of all species were 10.3% above 1969. This was disclosed by preliminary figures from Mexico's Secretary of Industry and Commerce.

Anchovy led: up 33.4%; shrimp landings increased 26.5%. Among industrial products, fish-meal production was up 33% over 1969; however, Mexico still needed to import 78,063 tons to meet her requirements.

Shrimp Still No. 4 Export

As a result of increased production, shrimp exports, mostly to the U.S., jumped 21.8% to US$63.1 million. Shrimp retained fourth place among exports, after sugar, cotton, and coffee.

CHILE

1970 FISH-MEAL PRODUCTION DOWN FROM 1969

Chilean fish-meal production during 1970 was only 162,627 metric tons, about 63,000 less than 1969, reports the Corporacion de Pesca S.A. (CORPESA).

Exports of fish meal during 1969 were 145,139.8 metric tons; exports of fish meal during 1970 were estimated at 110,000 metric tons worth US$17.9 million.

Production of fish oil was 19,447 metric tons in 1970, about 11,000 metric tons below 1969. Exports were 9,512 metric tons in 1969 and are estimated at 7,500 metric tons for 1970. (U.S. Embassy (FAS) Santiago)

ASIA

JAPAN

FISHERY CATCH IN 1970 TOPPED 9 MILLION TONS

Japan's fishery catch, excluding whales, reached a record 9,275,000 metric tons in 1970, according to the Statistics and Survey Division, Ministry of Agriculture and Forestry. The figure is 662,000 tons, or 8%, above 1969's 8,613,000 metric tons.

	1970	1969	+ or - from 1969
	(No. of Whales)		%
WHALING:			
Whalebone whale (blue-whale units)	2,422.49	2,510	-3
Sperm whale	6,548	6,668	-2
Minke and other species	624	1,415	66

The increase was attributed primarily to the sharp rise in Alaskan pollock catch in North Pacific mothership-type trawl fishery, good mackerel fishing in purse-seine fishery, and increased trawl catches off Hokkaido.

* * *

NORTH PACIFIC SALMON MOTHERSHIP FLEETS ACHIEVE QUOTA

The 11 Japanese salmon motherships that began fishing in Area A (north of 45° N. lat. and west of 175° W. long.) in the North Pacific on May 20 attained their 1971 salmon catch quota of 37,357 metric tons. The operations ended four days earlier than in 1970.

The 1971 high-seas salmon fishery was characterized by: (1) low ratio of red salmon catch (estimated 22-23% of total landings); (2) abundance of chum and pink; (3) absence of concentrations of Bristol Bay reds (result was that only the 2 fleets operating off Aleutians caught small reds during final weeks; and (4) landings of king and silver salmon were small, possibly because season was too early. ('Suisan Tsushin', July 19.)

* * *

SURVEY SQUID RESOURCE OFF CALIFORNIA

The newly formed semigovernmental Marine Fishery Resources Development Center of Japan was scheduled to charter the 300-gross-ton vessel 'Ryo-un Maru' this summer to survey the squid resource off California. The objective is to locate new grounds for large squid vessels. These vessels are having trouble because under Japanese licensing system they cannot operate in Japanese coastal fishery and, farther offshore, squid abundance has diminished considerably in recent years.

The Center's Job

The Center is collecting data on the squid catch of Japanese tuna longliners and of U.S. squid fishery off California. Over 40 U.S. vessels fish during the April-August season. They harvest over 10,000 tons annually.

California vessels report squid concentrations fairly close to shore. For Japanese fishermen, therefore, the most important question is how much squid can be taken in deeper offshore waters.

* * *

EXPLORE FOR SKIPJACK TUNA OFF SOLOMON ISLANDS

The Japanese Taiyo Fishing Co. has sent 2 tuna motherships to the Solomon Islands area in the South Pacific on a skipjack resource development cruise. They are 'Satsu Maru No. 18' (500 tons, 450-ton carrying capacity), and 'Kairyu Maru' (450 gross tons, 300-ton capacity).

Taiyo plans to establish in Guadalcanal and other islands 2-3 bases of operations for these motherships. The latter will buy skipjack from four 39-ton Okinawan vessels.

Taiyo is also exploring for skipjack off the Fiji Islands for FAO.

JAPAN (Contd.):

Other Firms Already There

Among major Japanese fishery firms, Taiyo is a late comer to the South Pacific skipjack fishery. Kyokuyo, Hokoku Suisan, and the Overseas Fishery companies already are conducting "exploratory" fishing off Papua-New Guinea and Nichiro off Halmahera Island near Molucca Sea. ('Katsuo-maguro Tsushin')

* * *

HOPE TO BREED SEA BREAM AND FLATFISH BY 1972

Commercial cultivation of marine fish in Japan is an ancient and profitable business. However, fish farming generally has been limited to a few species: shrimp, octopus, eels, yellowtail, and clams. Other marine species are being cultivated but largely on an experimental basis. Now the Japanese will culture red sea breams ("Ma-dai," CHRYSOPHRYS MAJOR) and flatfish ("hirame," PLATICHTHYS STELLATUS, or bastard halibut).

Sea Bream & Flatfish

For the past 3-4 years, scientists at Kinki University's fishery experimental laboratory have been breeding and raising sea bream and flatfish. The fish are grown in 30 water tanks. Each tank is about 3 feet high, holds a half-ton of water, and contains 3,000 fry.

Scientists have succeeded in coloring the sea bream a suitable pink (the Japanese consumer is highly conscious of fish coloring) by feeding the sea bream special foodstuffs. Recently, the lab sold samples of the sea bream on the open market; they were favorably received.

Building Incubation Facilities

With financial support from the Shirahama Fishery Cooperative, Kinki's techniques will be put into practice. Several incubation facilities are being built at a 6,600-sq.-meter site at Sakata Beach, near Shirahama City. The facilities, costing US$416,000, are scheduled to be completed in March 1972. The project will mass-produce "finned" fish, which are considered difficult to raise artificially. Shigeru Iwasaki, director of the Shirahama Fishery Cooperative, has said that fish farming throughout Japan would benefit due to a stable supply of fry produced by the incubation facilities. Orders for the young fish are said to be "pouring in." ('Japan Times')

* * *

38 VESSELS LICENSED FOR HIGH-SEAS SAURY FISHERY

The Japanese Fisheries Agency has licensed 38 vessels for experimental high-seas saury fishing in 1971 in the North Pacific east of 160° E. long. The agency is expected to make a decision on the remaining 10 of the 48 vessels that applied this year.

* * *

LARGEST STERN TRAWLER JOINS BERING SEA FLEET

The 5,300-gross-ton 'Tenyo Maru', Japan's largest stern trawler, was delivered to its owners on May 20, 1971. After running trials, the vessel departed on June 1 for the Bering Sea. There it will engage primarily in "surimi" (minced fish) and fish-meal production for 7 months. Production target is 4,000 tons of frozen surimi, 2,000 tons of fish meal, and 1,000 tons of frozen fish.

Cost $4.7 Million

The vessel cost 1,700 million yen (US$4.72 million). It is 366 feet long, 55.8 feet wide, and 36.7 feet deep. Main engine is 5,700 hp., maximum speed 17.3 knots. It can accommodate a crew of 115. ('Nihon Suisan Shimbun', June 7)

Larger One On Way

The 5,500-gross ton factory trawler 'Chikubu Maru' was scheduled to be launched at the Usuki Ironworks on June 13, 1971. When completed in late October, it will be Japan's largest and fifth 5,000-ton class trawler. In mid-November, it will be sent to the Bering Sea trawling grounds.

Main specifications are: length 342 feet, width 58.4 feet, depth 36.1 feet, 5,700-hp. main engine, and speed of 15.5 knots. The ship will carry a 122-man crew. ('Suisan Tsushin')

* * *

JAPAN (Contd.):

JAPANESE TO FORM COMPANY IN MAURITANIA TO OPERATE ICE BOATS

In early 1971, Mauritania and several Japanese fishing firms reviewed a 1-year agreement. Under it, the Japanese are sending 11 ice-carrying fishing boats and will form a local corporation to operate them.

The new company, to be named Mauritania Suisan Marine Products Co. will be established in Nouadhibou with Japanese paid-up capital of 40 million CFA francs (about US$150,000).

Ice Boats There

Most of the ice boats arrived at Nouadhibou in May and are fishing; the rest were expected in June. The agreement provides for the Japanese to help in the development of Mauritania's fishing industry. The vessels will fish in the coastal waters with arrangements to export catches to Japan. ('Suisan Keizai Shimbun')

* * *

COLD-STORAGE PLANT BEGINS OPERATIONS

The firm Kenya Fishing Industry has a new 2,000-ton cold-storage plant at Mombasa processing tuna. The plant is operated jointly by two Japanese firms (Taiyo & Ataka Sangyo), local business interests, and the Kenyan Government. The firm was established with US$167,000 (60 million yen), one-third each by participants.

Tuna Base

Taiyo is using Mombasa port as a tuna-fishing base under an exclusive agreement. Previously, it used a refrigerated fish carrier anchored offshore to store tuna caught in the Indian Ocean.

10 Longliners Off Mombasa

In 1970, 20 Taiwanese and 2 Okinawan tuna longliners supplied Mombasa under a contract with Taiyo. In mid-June 1971, the 10 longliners off Mombasa were catching about 2.5 tons a day (about 50% yellowfin, 25-30% bigeyed; the remainder marlin and other species). ('Katsuo-maguro Tsushin')

THAILAND: Harvesting tilapia from a fish farm. (FAO)

SOUTH PACIFIC

NEW ZEALAND

EXPORT WELL-BRED EELS

New Zealand has escaped pollution of its natural waterways so far, says the country's information service. This is good for eels--and for New Zealand's export market.

Until about 1953, New Zealand eels were unknown to the world's eel eaters. The story is different today.

Eels spawn hundreds of miles from New Zealand. The small leaf-shaped creatures (Leptocephalus), carried by ocean currents, arrive in the spring as small transparent glass eels. They make their way up many rivers and streams around the country to the headwaters; they grow as they progress. After 3 or 4 years, they are ready to migrate. This normally begins towards end of February and lasts 4 to 6 weeks. During migration, the best eels are caught for processing and export.

A Dutchman Pioneered

The catching and exporting of eels were pioneered by a Dutch migrant. He had handled and processed eels in Holland and knew Dutch and European markets. Most eels exported from New Zealand have been "live frozen," not eviscerated. In recent years, however, the method adopted by the Dutch migrant has produced change: eels are now cleaned and deslimed before freezing. Considerable improvements have been made in trapping, handling, and processing eels. Packing plants are required to meet high standards of cleaniness and hygiene.

Packed Many Ways

Eels are packed in several ways to satisfy foreign customers. They are available block frozen alive; frozen alive, each eel interleaved; stick frozen alive; gutted and deslimed, head on; completely dressed; and in fillet form with skin off or on. In some cases, individual fillets are frozen and glazed; in other cases, a solid block of fillets with skin off is prepared for special orders, or smoked whole. Solid block, individually wrapped and smoked eel fillets in small retail packs, or large fillets also are available to catering trade. Not all processors provide so many products.

In most cases, eels are double-glazed, and cartons polythene-lined. Carton sizes vary with customer requirements, but the net weight ranges between 10 and 15 lbs. (5.53 and 6.80 kgs.). Some packers of smoked eels provide these in cartons between 10 and 30 lbs. (5.53 and 13.60 kgs.) to suit customers. The demand for smoked eels is growing.

Eels Graded

The eels are graded. First step determines which eels are most suitable for the various processes; the second is a grading to size to suit customers. Generally, the short-finned (Anguilla australia) are required in 1-2 lbs. (0.45-0.90 kg.) or 2 to 4 lbs. (0.90 to 1.81 kgs.) sizes. The long-finned (Anguilla dieffenbachi) are asked for mainly in 1 to 2 lbs. and 2 to 3 lbs. (0.90-

1.36 kgs.). Some customers specify 4 to 10 lbs. (1.81 to 4.53 kgs.) long-finned eels for canning and similar purposes.

The long-finned eel attains 35 to 40 lbs. (15.86 to 18.14 kgs.). These very large eels are not used. But they are of high-enough quality for canning, jellied eel fillets, and for sausages. Most processors could supply the very large long-finned eels.

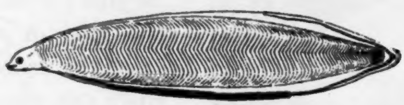
Large Export Potential

The potential for eel exports is so large that New Zealand's Fishing Industry Board began investigating the possibility of farming them. They used the methods of Japan's long-established industry. Following the visit of Dr. Isao Matsui, a leading authority on eels, to advise Board, the interest in exporting glass eels to Japan grew. When results of this experiment being conducted in Japan become known, they will show whether New Zealand glass eels can be farmed under Japanese conditions.

At same time, research has begun in New Zealand on the eel's life cycle. Practical experiments are under way to grow baby eels in ponds. Eel farming is successful in Japan, and New Zealanders hope they too can put it on a sound basis.

Rapid Industry Growth

The eel industry has grown rapidly. Next to rock lobsters, eels are the most important fish export. In 1967, eel products were worth NZ$79,737; the estimate for 1970 exports was NZ$454,000. New Zealand exports eels to West Germany, Netherlands, Japan, Australia, U.S., Britain, South Africa, Italy, and Sweden.



Leptocephalus

Late-stage Leptocephalus

FIND OCEAN QUAHOGS ABUNDANT OFF MASSACHUSETTS

Large quantities of ocean quahogs were found in the near-shore waters off Ipswich and Gloucester, Massachusetts, during experimental fishing from the 57-foot Gloucester trawler 'Jo-Ann', April 18-May 6. Catch rates up to 30 bushels per hour of the large, 3- to 4-inch-long, edible molluscs were achieved in 10 to 15 fathoms just north of Cape Ann, Mass.

Fig. 1 - Catch of Ocean Quahogs on deck of Gloucester trawler Jo-Ann.

Funds to charter Jo-Ann were supplied by Economic Development Administration (EDA); fishing equipment and technical direction were provided by NMFS. The captain and 3-man crew fished.

Principal objectives were: (1) to investigate potential of underutilized clam resources in Gloucester area; (2) to test adaptability of a small New England dragger for conversion to hydraulic jet dredging. Both objectives were reached.

Results Encouraging

The results were encouraging enough to suggest that more, formally planned surveys might accelerate establishment of a small-boat jet-dredge clam fishery in Gloucester area. The converted and equipped Jo-Ann proved an effective and efficient clam dredge vessel.

Gear

A hydraulic jet dredge with a 32-inch fixed blade was fished. The dredge was used with a diesel-powered centrifugal pump that supplied water under pressure (70 p.s.i. on deck) through a 5-inch hose to the dredge manifold and jets. A double-drum trawl winch was driven by a power take-off from the main engine. One winch drum contained $\frac{1}{2}$-inch wire rope used for setting and hauling the dredge. The other winch drum contained 1-inch nylon rope for towing the dredge.

Fishing Procedure

(1) The dredge hose was let out over the stern. (2) The dredge was lifted over the side and lowered to ocean bottom by $\frac{1}{2}$-inch wire rope from one winch drum. This wire passed through a block on the end of a heavy boom. At the same time, the nylon towing rope was spooled off of the other winch drum in amount needed. The tow rope passed through a hanging block at the center of the deck and over the stern. (3) The centrifugal pump was

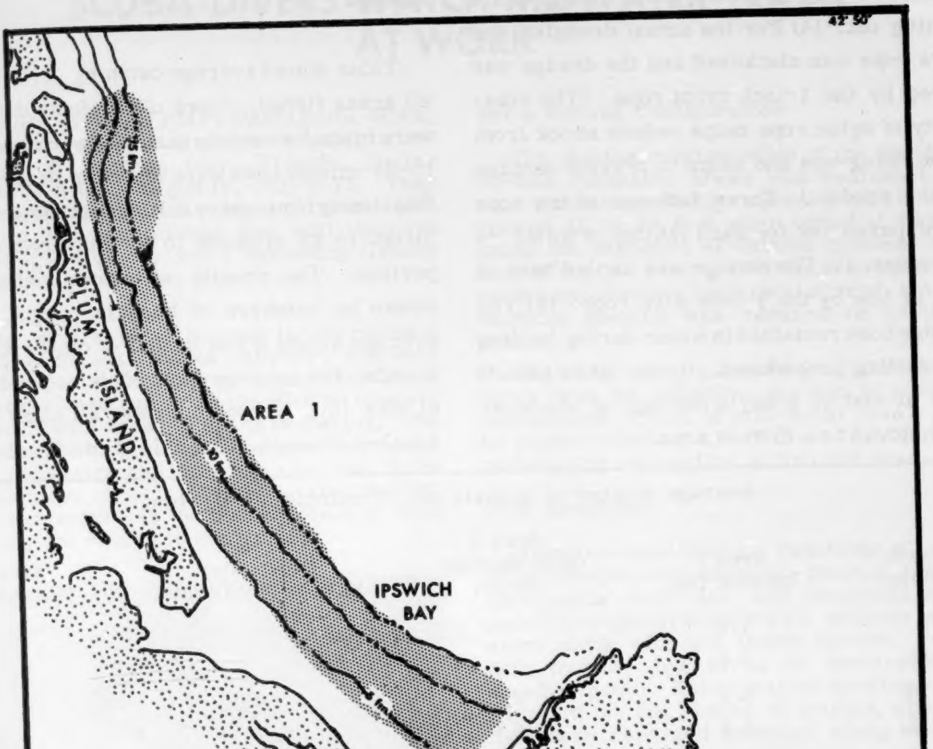


Fig. 2 - Ocean quahog area surveyed April 18-May 6, 1971.

started to supply water to the dredge while setting out. (4) For the actual dredging, the wire rope was slackened and the dredge was towed by the 1-inch nylon rope. (The elasticity of nylon rope helps reduce shock from minor hang-ups and helps to prevent damage to the dredge.) Three fathoms of tow rope were payed out for each fathom of water--a 3:1 scope. (5) The dredge was hauled back at end of tow by the $\frac{1}{2}$-inch wire rope. (6) The dredge hose remained in water during hauling and setting procedures. It was taken aboard only at end of a day's fishing, or whenever boat moved to a distant area.

Results

Table shows average catch by depth(s) for all areas fished. Tows of 5-minute duration were made for routine sampling purposes, and 15-45-minute tows were made for production. The towing time and resulting catches are adjusted to 15 minutes to permit direct comparison. The density of ocean quahogs is shown by numbers of bushels caught. The average weight of one bushel of clams was 75 pounds. The average count of clams per bushel was 160. The clams were all about $3\frac{1}{2}$ to 4 inches in length. The yield of edible meats--determined by NMFS Gloucester Fishery Products Technology Laboratory-was about 11 pounds per 80 lb. bushel of whole clams.

Time did not permit more intensive and/or systematic survey. However, table indicates significant concentrations of clams in all four areas sampled. The most productive was in Ipswich Bay, 1 mile north of Annisquam River entrance buoy in 10 to 15 fathoms.

Average number of bushels per 15-minute towing time

Depth Fathoms	Area 1 Ipswich Bay	Area 2 Good Harbor Beach	Area 3 Gloucester Harbor Breakwater	Area 4 Manchester
5-6	1.5	--	--	--
7-8	5.9	--	--	--
9-10	4.3	6.0	9.0	--
11-12	6.5	6.7	--	--
13-15	8.8	3.0	--	2.2
20	--	3.0	--	--

-- indicates depths not surveyed.

Area of Operation

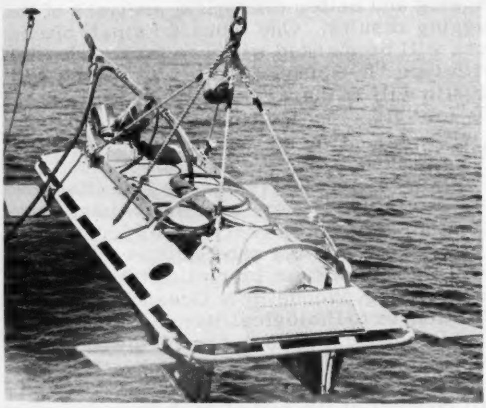
Four areas were fished (see chart). One in Ipswich Bay (Area 1), depth range of 5 to 15 fathoms, was selected for major part of dredging. Other areas sampled included Good Harbor Beach (Area 2), an area 1 mile SW of Gloucester harbor breakwater (Area 3), and off Singing Beach near Manchester (Area 4).

For more information, contact Keith A. Smith or Warren D. Handwork, NMFS Exploratory Fishing and Gear Research Base, Woods Hole, Massachusetts 02543. Telephone: (617) 548-5123.

SCUBA DIVERS WATCH MIDWATER TRAWL AT WORK

SCUBA divers of NMFS Pascagoula, Miss., were able to observe a midwater trawl in operation off Panama City, Florida, during Cruise 28 of the 'Oregon II', July 6-11. They were preparing for a project to develop an electric midwater trawl that will improve sampling efficiency when assessing fishery resources of the open sea.

The divers were trained in operating a towed diving sled named 'RUFUS'; 5 divers have checked out on this vehicle. Techniques were developed for using the sled to observe the midwater trawl while it is fishing. The sled transports the divers from surface to the net. The divers can leave the sled tied to the net and move about. After observing the net, they can return to the sled, release it from the net, and return to the surface.



RUFUS--Remote Underwater Fisheries Assessment System. (Photo: A. J. Barrett)

The divers observed the net at towing speeds of 2, 3, and 4 knots. The maximum towing speed for meaningful observation is about 3 knots. At 4 knots, it takes considerable effort to ride the net, and observations become almost impossible.

Net's Fishing Configuration

The fishing configuration of the standard 30-foot midwater trawl was evaluated. It was almost perfectly square: each side spread 20 to 25 feet when towed at 3 knots using the standard 40-fathom bridles. Observations when using 10-fathom bridles revealed satisfactory horizontal spread, but the vertical opening was reduced to 10 to 15 feet.

Trawling along a line of artificial structures was an effective method to position fish schools in path of mid-water trawl--and to permit efficient use of diver time for observing the interaction of fish and gear.

Fish Reactions

The divers watched the reactions of round scad (Decapterus punctatus), Spanish sardine (Sardinella anchovia), and numerous small jack (Carangidae) to the trawl. Schools would swim along with and inside the net. Often, they moved back 20 to 30 feet inside the trawl's mouth. There was no herding effect apparent at the doors of bridles, although fish were observed to school along with the doors.

The fish often appeared to be feeding on particulate material while swimming inside the trawl mouth at towing speeds over 3 knots. When frightened, they were easily capable of burst speeds to escape the net. The divers often reported over 1,000 pounds of fish swimming in and around the net--but catches always were less than 100 pounds when the trawl was brought aboard.

Fish Within Range

The presence of fish in and around the trawl mouth places them well within range of the electric field for the proposed electric midwater trawl. No difficulty is expected from placing the electrode hardware around the mouth of the net.

1971 STOCKING PROGRAMS IMPROVE GREAT LAKES FISHERIES

U.S. and Canadian waters of the Great Lakes this year will receive 15-16 million hatchery-reared fish. The stocking of over 8.5 million coho and chinook salmon is a record for these species. The State of Michigan introduced the coho in 1966 and the chinook in 1967. Ontario has been releasing another salmonid, the kokanee, since 1965; this year 1.1 million were stocked in Lake Ontario.

Lake trout plantings for 1971 are slightly over 4 million yearlings. These are about equally divided between lakes Superior and Michigan. There, stocking programs to restore this fishery nearly destroyed by the sea lamprey have been underway--since 1958 in Superior and since 1965 in Michigan. Rehabilitation is being conducted along with lampricide treatment of the streams where the predator sea lamprey spawns.

Besides planting 13.8 million young salmon and lake trout, the release schedules of state and provincial fishery agencies include over 2 million young fish of other trout species and walleyes.

For the salmonids and lake trout, the total annual plantings in the Great Lakes through 1971 are: lake trout 43.5 million; coho 20.5 million; chinook 9.3 million; and kokanee 15.4 million (including 2 million eggs in 1965-66).

Lake Michigan

Lake Michigan will receive about half the fish released in the Great Lakes this year--slightly under 7 million coho, chinook, and lake trout, and about 900,000 other trout: brown, brook, and rainbow or steelhead. About 4.1 million of the State of Michigan's 6.5 million salmon were planted in this lake in 1971. Originally, Michigan planned a spring release of about 4.5 million coho and 3 million chinook in the state's Great Lakes waters. But the winter toll of young fish reared in outdoor ponds reduced by a half-million the stocking of each species.

Michigan also supplies a large share of the coho eggs going into the hatcheries in other lake states and Ontario; the remainder come from the west coast and Alaska.

ICCAT TUNA-TAGGING EXPERIMENT BEGINS OFF NORTHEAST U.S.

If you find a tag on a tuna or billfish, you will be eligible for a $300 jackpot to be offered by the International Commission on the Conservation of Atlantic Tunas (ICCAT). The chances will be excellent with any bluefin tuna catch because 1,000 are being double-tagged this summer in a new ICCAT-proposed international experiment.

Conducting the study are Woods Hole Oceanographic Institution, Woods Hole, Mass.; NMFS Tropical Atlantic Biological Laboratory, Miami, Florida; and the St. Andrews Biological Station of Canada's Fisheries Research Board. The coordinator is Frank J. Mather of Woods Hole.

The experiment is being conducted off the U.S. northeastern seaboard. It is designed to compare the effectiveness of two widely used types of tags. The planners say the results should permit more efficient and uniform tagging and better statistical analyses of the tagging results. One thousand small bluefin tuna will be marked with two tags each--500 with type "D", 500 with type "H". Additional bluefin will be marked with single tags, either "D" or "H".

Data Sought

Fishermen who recapture the fish are urged to return all tags with these data: date, location, method of recapture, length, and weight of fish. Tags can be turned over to a local fishery officer, or mailed either to address on tag, Woods Hole Oceanographic Institution, or to Biological Station, St. Andrews, New Brunswick. These agencies will pay $5 for each tag. The number of each will be entered in the drawing for the $300 prize ICCAT will conduct at the end of each year.

Program Objectives

The experiment will help define the bluefin tuna's migratory patterns and populations; also, it will help to estimate the effects of large-scale commercial fishing on the northwestern Atlantic stock. Previous results indicated this stock is small and heavily exploited. Before the new experiment, ICCAT had recommended that commercial fishing of bluefin tuna under 23 pounds be discouraged.

Tag returns have revealed mass migrations of small bluefin tunas across the Atlantic in both directions. Catch statistics indicate that these migrations, which appear to occur irregularly rather than annually, have affected commercial fisheries decisively. Cooperating sport fishermen have provided valuable data.

Principal support for the tagging project comes from NOAA's National Sea Grant Program. Matching funds have been donated by the Sport Fishing Institute, fishing clubs, and sport fishermen.

ICCAT

The International Commission for the Conservation of Atlantic Tunas (ICCAT) became effective in 1969 after ratification by seven nations: U.S., Canada, Japan, South Africa, France, Ghana, and Spain. It is headquartered in Madrid. The convention was drafted in Rio de Janeiro in 1966 by delegates from 17 nations. It was the first such international conference in which sport-fishing interests were represented.

NMFS JOINS NEW YORK IN LOBSTER STUDY

In early June, biologists of the New York State Conservation Department and the NMFS Biological Laboratory, Boothbay Harbor, Maine, cooperated in ecological and tagging studies. They were investigating the mixing of offshore with inshore lobster populations along the south shore and eastern tip of Long Island.

About 500 lobsters were caught, tagged, and released in eastern portion of Long Island Sound, off Montauk Point, and Long Island's southeastern shore.

What Tag Returns Will Show

The amount and distribution of tag returns in the coming year will distinguish inshore from offshore lobsters. Also, these returns will document further seasonal movements, exploitation rates, growth, and degree of stock mixing.

WHY MANY FISH DIE DURING RED TIDE INVASION

Researchers of the University of Southern California's Allan Hancock Foundation and Sea Grant Programs report they have the scientific answer to why many fish die during the Red Tide invasion of southern California's coastline.

It was believed previously that consumption of oxygen during the decomposition of dead one-cell microorganisms of the Red Tide in California waters killed fish. Now the USC researchers have determined that the fish kill results directly from a toxin within the one-cell microorganisms of the Red Tide, according to Dr. Bernard C. Abbott, Hancock Director.

The toxin in Red Tide cells, taken in samples from the Hermosa Beach pier area, was isolated by an extractive method. It "affected immediate kill in a laboratory fish population," Dr. Abbott reported.

Working with Dr. Abbott were Mikihiko Oguri of Whittier, research associate, and visiting professors Michael Spiegelstein and Z. Paster of Israel's Tel Aviv University.

The Toxin

The toxin isolated by the researchers is retained within the Red Tide's one-cell organisms (Gonyaulax polyhedra) until the cell dies. "Because the current Red Tide population off our coast is a living population, the toxin is retained in the cells and will produce fish kills only when a large number of the cells die," Dr. Abbott said. He has studied the California and Florida Red Tide populations. "These are unrelated species. The Florida organisms release their toxin into the environment while in their living state. This produces large fish kills and can cause both throat and mouth irritations in man."

SLOPING BEACH IS BEST PROTECTION AGAINST EROSION

Natural and manmade erosion is a very serious problem along Florida's shores, reports the State's Bureau of Beaches and Shores. Measurable damage from beach erosion over the years has reached millions of dollars. No price tag can be put on probably the greatest damage--the loss of valuable recreational areas. Over 200 miles of once-beautiful beaches have been eroded so much that they must be restored artificially.

The problem has become so serious that it is necessary in many areas to line the shores with massive rock piles to protect upland development. In some areas, many other protective devices have been installed to rebuild eroded beaches.

To increase the protection of upland development, hundreds of miles of seawalls have been constructed along the shorelines. These seawalls may have some value, but they contribute to beach erosion. Where seawalls are necessary, they should be located well landward of the beach foreshore, says the Bureau.

The best protection for upland development is a wide, gently sloping beach. The sea's energy is spent without eroding the beach.

What To Do?

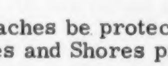
How can beaches be protected? The Bureau of Beaches and Shores proposes:

"First, we must recognize the fact that our beaches are vital to the economic well-being of the State, as well as being important to the citizens of the state for recreation and enjoyment. Therefore, it is necessary to exercise a certain amount of control for the protection of the beaches.

"Structures must be kept far enough away from the water to prevent damage to the beach.

"Efforts must be made to bypass sand around inlets and rivers which interrupt the littoral drift.

"When a beach has been severely eroded we must go offshore, outside of the beach system, and pump sand back onto the beach. This appears to be the best solution to the problem in the long run. However, such a program is expensive and requires the support of all levels of government."



VIMS OCEANOGRAPHERS STUDY NUCLEAR POWER PLANT DISCHARGES

Physical oceanographers of the Virginia Institute of Marine Science are working on one of the first detailed before-and-after analyses of waste-heat discharge into an estuary by a nuclear electric-generating facility. Their research, under a 3-year contract with Atomic Energy Commission, also will yield information on the accuracy of present scientific methods of predicting these effects.

Scientists and technicians are constantly recording James River data near Hog Island, where the large VEPCO Surry County Nuclear Generating Facility is nearing completion. All data are recorded automatically on tape, translated by computer, and will be published periodically. Dr. W.J. Hargis Jr., VIMS director, said: "We are collecting pre-operational background data now. Then we will continue the survey at Surry Point after one nuclear generator unit and, at a later date, after two nuclear generator units are made operational."

Surveying & Monitoring

Dr. C.S. Fang, head of Department of Physical Oceanography and Hydraulics and principal project investigator, added: "We are taking data three ways. We are surveying and monitoring aboard the VIMS research vessel 'Investigator' twice weekly. Very sensitive thermal equipment and tide gauges continuously record data from seven VEPCO concrete towers located in the river at key points near the facility. Also, through the cooperation of NASA-Wallops, we routinely fly over the area for infra-red aerial photographs."

Dr. Hargis noted that this environmental study of waste-heat discharge into an estuary will involve, when the Surry plant is ready, one of the greatest amounts of waste heat effluent ever studied in such detail.

THREAD HERRING DISTRIBUTION OFF FLORIDA'S WEST COAST

Brian S. Kinnear and Charles M. Fuss Jr.

The thread herring (Opisthonema oglinum) is essentially a coastal pelagic species. Data suggest a seasonal north-south migration along Florida's Gulf coast almost entirely within state territorial waters (nine nautical miles from shore).

Abundance in major estuarine systems varies seasonally. Commercially valuable concentrations of thread herring occur near Ft. Myers, Florida, during the winter. The prospects for a commercial fishery are discouraging because legislation now prohibits the use of purse seines in state waters and because thread herring are not abundant outside state waters.

The thread herring is a migratory clupeid often found in abundance along Florida's Gulf coast. Bullis and Thompson estimated in 1967 that stocks in the Gulf of Mexico may approach one million tons; Sykes suggested in 1968 that the resource might sustain an annual catch of 500,000 tons.

Attempts have been made to harvest winter concentrations near St. Petersburg and Ft. Myers, Florida (Butler, 1961; Fuss, 1968). Although the fishery has developed within Florida state waters (nine nautical miles offshore) and is under state jurisdiction, the resource has national interest: 1) the fish are migratory; 2) the fish products are distributed in interstate commerce; and 3) the entire nation benefits from the utilization of domestically produced fish meal and oil.

The National Marine Fisheries Service (formerly Bureau of Commercial Fisheries) anticipated an important fishery. It began studies in 1967 to insure a sound base for eventual management of the fishery. Recent state legislation, however, has effectively closed the fishery by prohibiting the use of purse seines in waters along much of Florida's Gulf coast.

Close contact was maintained with industry as the fishery developed. Plant operators and fishermen were very cooperative in providing biological samples and catch statistics. They followed our research with interest. This report summarizes ours and other data related to thread herring distribution along Florida's Gulf coast.

SOURCES OF DATA

We sought to achieve a synoptic view of the range and movements of thread herring along Florida's Gulf coast. We reviewed data from many sources: progress, cruise, aerial-survey reports, and unpublished data from Exploratory Fishing and Gear Research Base Pascagoula, Mississippi; log-book data and aerial surveys from fishing industry; statistical data developed by the National Marine Fisheries Service; and unpublished aerial survey reports by Florida's Department of Natural Resources.

We plotted catch records and aerial sightings by latitude and longitude without reference to date of collection and observation and made no attempt to include vessel or flight

The authors are Fishery Biologists, NMFS Center for Estuarine and Menhaden Research (Field Station), St. Petersburg Beach, Florida 33706.

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tracks. Although this procedure obscured year-to-year changes in distribution, it provided a record of historic range.

To determine the distribution of thread herring in Tampa Bay and adjacent areas, we systematically collected fish in gill nets at a series of fixed stations (Figure 1). In Tampa Bay, stations were selected to assess the importance of an estuary as a sanctuary and as a reservoir for the coastal fishery. Inshore stations between Ft. Myers and St. Petersburg were occupied to determine the winter distribution of thread herring northward of the commercial fishery (Fuss, Kelly and Prest, 1969). In the St. Petersburg area, we established a transect or line of stations offshore to estimate the distribution pattern within and beyond state waters. The state boundary, nine nautical miles offshore, was located midway along the transect.

Our standard unit of effort for all stations was a two-inch mesh (stretch measure) monofilament gill net, 300 x 10 feet, fished for 30 minutes. A gill net 20 feet deep, same size mesh and length, divided lengthwise with a spacer at 10 feet, provided the equivalent of two units of effort fished simultaneously at different depths. The catch per unit of effort was calculated for each 10-foot section. From January to July 1970, we sank an additional unit of gear at each transect station beyond three miles to insure getting thread herring below 20 feet.

DEVELOPMENT OF COMMERCIAL FISHERY

Incidental catches of thread herring in the Gulf menhaden fishery were first noticed in 1948 (Miles and Simmons, 1950; Christmas, Gunter and Whatley, 1960). During the next eight years, fishermen had little interest in thread herring because they were harder to catch than menhaden and were not generally available on menhaden grounds. However, after Gulf menhaden landings slumped over 30% in 1957, the industry began to investigate alternate resources (Butler, 1961). NMFS cruise and aerial-survey reports convinced some people in the menhaden industry that commercial quantities of thread herring were concentrated along Florida's Gulf coast during the winter.

In fall 1958, NMFS began experimenting with lampara seines near St. Petersburg to correct deficiencies noted earlier when this gear had caught thread herring for a baitfish fishery. In hopes of lowering costs of catching menhaden, segments of the menhaden fishery also began experimenting with lampara seines. These experiments were inconclusive during the 1958-59 menhaden season. They were shifted to the St. Petersburg area where thread herring stocks were available. More gear modifications by NMFS produced thread herring catches as great as 27 tons per set.

In turn, this demonstration of resource availability stimulated experiments with the standard 2-boat purse-seine technique. These were expanded in 1959-60 to include the single-boat purse-seine technique. The single-boat method produced thread herring catches ranging from 5 to 40 tons per set. But, by 1960, the Gulf menhaden fishery had recovered from the 1957 slump and produced record landings in excess of 400,000 tons. Interest in thread herring declined.

In 1966, NMFS aerial surveys and exploratory fishing cruises again indicated that thread herring were abundant. They occurred in more catch samples and were sighted more often than all other surface-schooling species combined (Bullis and Thompson, 1967). The development of a commercial fishery was encouraged by demonstration of the availability and size of the resource along the west coast of Florida (estimated at 750,000 tons by Bullis and Thompson, 1967) and indications of declining Atlantic menhaden catches (Nicholson, 1966). In 1967, a reduction plant was opened in Charlotte Harbor near Ft. Myers, Florida (Fuss 1968). The Florida west coast fishery, plagued by legal and other difficulties, remained small. It produced about 3,900 tons in 1967, 6,000 tons in 1968, and 2,800 tons in 1969. Virtually all fish were caught within the 10-fathom curve, between Latitude 26° N. and 27°N. Legal restrictions prohibited fishing off St. Petersburg, Florida. Rough bottom inhibited purse seining further north or south of these latitudes.

THREAD HERRING DISTRIBUTION

For the fishery, knowledge of the distribution of thread herring with regard to legal boundaries became as important as knowledge of the seasonal distribution. From July 1969 to June 1970, we made 73 gill net sets totaling 157 units of effort (Figure 1). Sixty-three

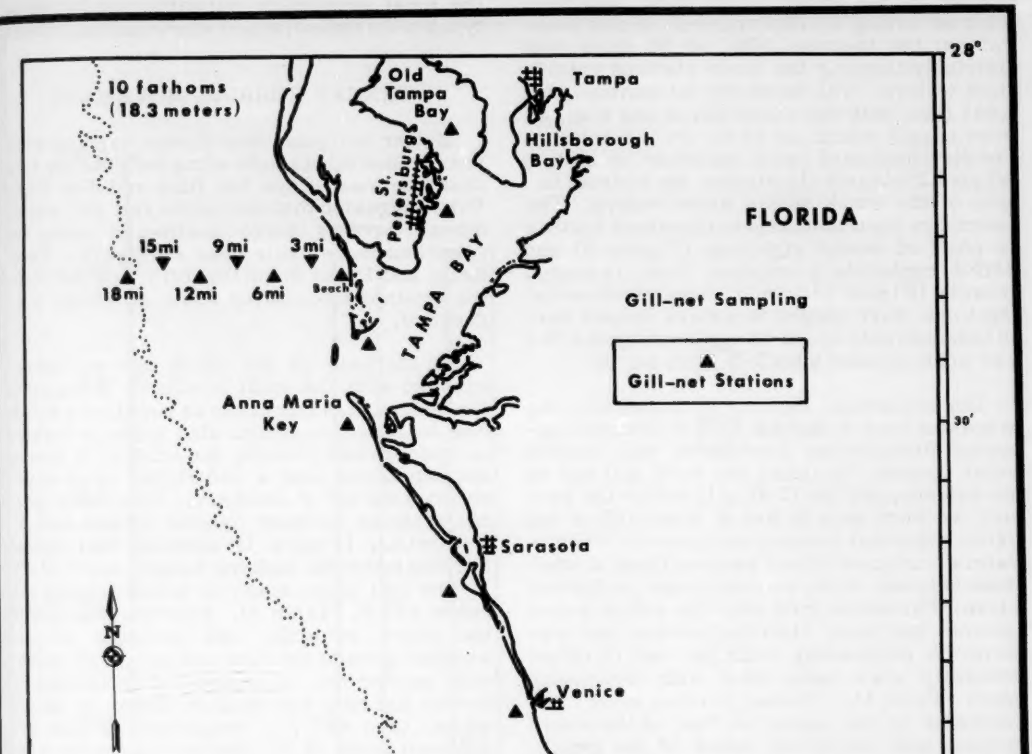

Fig. 1 - Locations of gill-net stations from Tampa Bay to Sanibel Island, Florida.

percent of the effort, or 99 units, was distributed among the four stations within state waters; the balance, 37%, or 58 units, was distributed among the three stations outside state waters. The catch for all stations was 2,683 fish; with the exception of one fish, all were caught within or at the state boundary. The distribution of catch and effort by station (Figure 2) clearly illustrates the coastal nature of the stock within state waters. The nearshore distribution is emphasized further by plots of aerial sightings (Figure 3) and NMFS exploratory catches from research vessels (Figure 4). Only three of 68 aerial sightings were logged in waters deeper than 10 fathoms; only one of 76 exploratory catches was made beyond the 10-fathom curve.

The occasional capture of thread herring in bottom trawls during NMFS cruises suggested distribution throughout the coastal water column. By using the 20-ft. gill net on the surface, and the 10-ft. gill net on the bottom, we were able to fish at least 85% of the water column at transect stations within state waters, and about 50% of water column at stations between state boundary and 10-fathom curve. Thread herring used the entire water column, but their distribution was not uniform. A decreasing catch per unit of effort generally was associated with increasing depth (Table 1). Thread herring were concentrated in the upper 10 feet of the water column and within six miles of the beach. Failure to catch thread herring on the bottom beyond nine miles (state boundary) during the winter and spring with 12 additional units of gear suggests the fish do not move into deep offshore waters.

Thread herring distribution in the Tampa Bay system appears to be modified by the industrial and domestic pollution that flushes from Hillsborough Bay (Figure 1). Pollution and dredge and fill projects have modified Hillsborough Bay so extensively that 42% of that bay has been classified unhealthy (Taylor, Hall and Saloman, 1970). The effects of pollution extend down Hillsborough Bay into the midsection of Tampa Bay. There, catches per unit of effort were only 8% of catch per unit of effort in Old Tampa Bay, and only 23% of catch in Tampa Bay Pass (Table 2). Our high catch per unit of effort at the Old Tampa Bay station (110 fish) exceeded the catch per unit of effort at all other stations; this indicates that Old Tampa Bay is a useful segment of thread herring range. Within the entire Tampa Bay complex, Old Tampa Bay is also the most productive nursery area for other types of fin fishes (Sykes and Finucane, 1964).

THREAD HERRING MOVEMENT

Butler indicated that thread herring were year-round inhabitants along the Florida Gulf coast between Cape San Blas and Key West. Fuss suggested that during the fall and winter thread herring move southward along the coast and concentrate near Ft. Myers. Fuss, Kelly and Prest found that effort on the fishing grounds also shifted south as winter progressed.

An increase in the catch per set corresponded with the shift in effort. It suggests that school size increases as population shifts. The increase in school size appears related to temperature; during the winter, it forces the population into a restricted area in advance of the 68° F. isotherm. Data from gill-net stations between Sanibel Island and St. Petersburg (Figure 1) confirm that thread herring leave the inshore waters north of Ft. Myers and move south as temperatures fall below 68° F. (Table 3). Yearly variations in the onset, severity, and duration of cold weather govern the rate and extent of southerly movement. Commercial quantities of thread herring are seldom found in water colder than 68° F., temperatures that are common north of Ft. Myers during the winter.

No thread herring were taken by gill nets off St. Petersburg during winter 1967 after surface temperatures dropped below 63° F. However, catches of thread herring in gill nets increased in the spring. The mean catch per unit of effort peaked when the temperature ranged between 81° F. and 84° F.

In 1970, thread herring returned to the St. Petersburg area by late February. They were collected at transect stations six and nine miles off the beach after surface temperatures began increasing from the January low. By March, surface temperatures had increased to 63° F. Incidental catches were made successively at the 9-mile, 6-mile, and 3-mile stations; this suggests movement toward the beach. The average surface temperature increased to 82° F. in April, and large catches were made at the 3-mile and 6-mile stations. The seasonal increase in catch is shown in Figure 5.

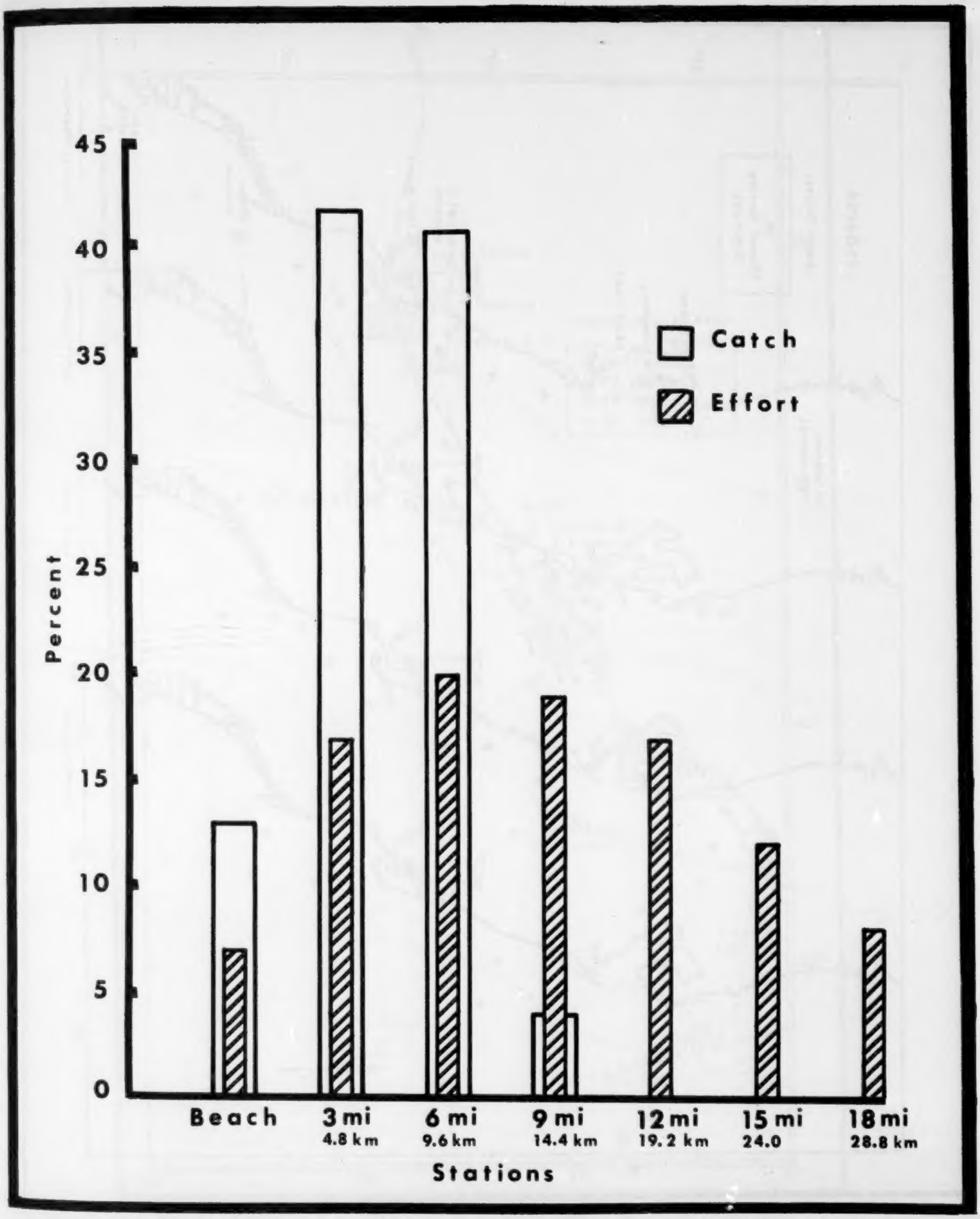

Fig. 2 - Percentages of total thread herring catch and total gill-net effort by transect station off St. Petersburg, Florida.

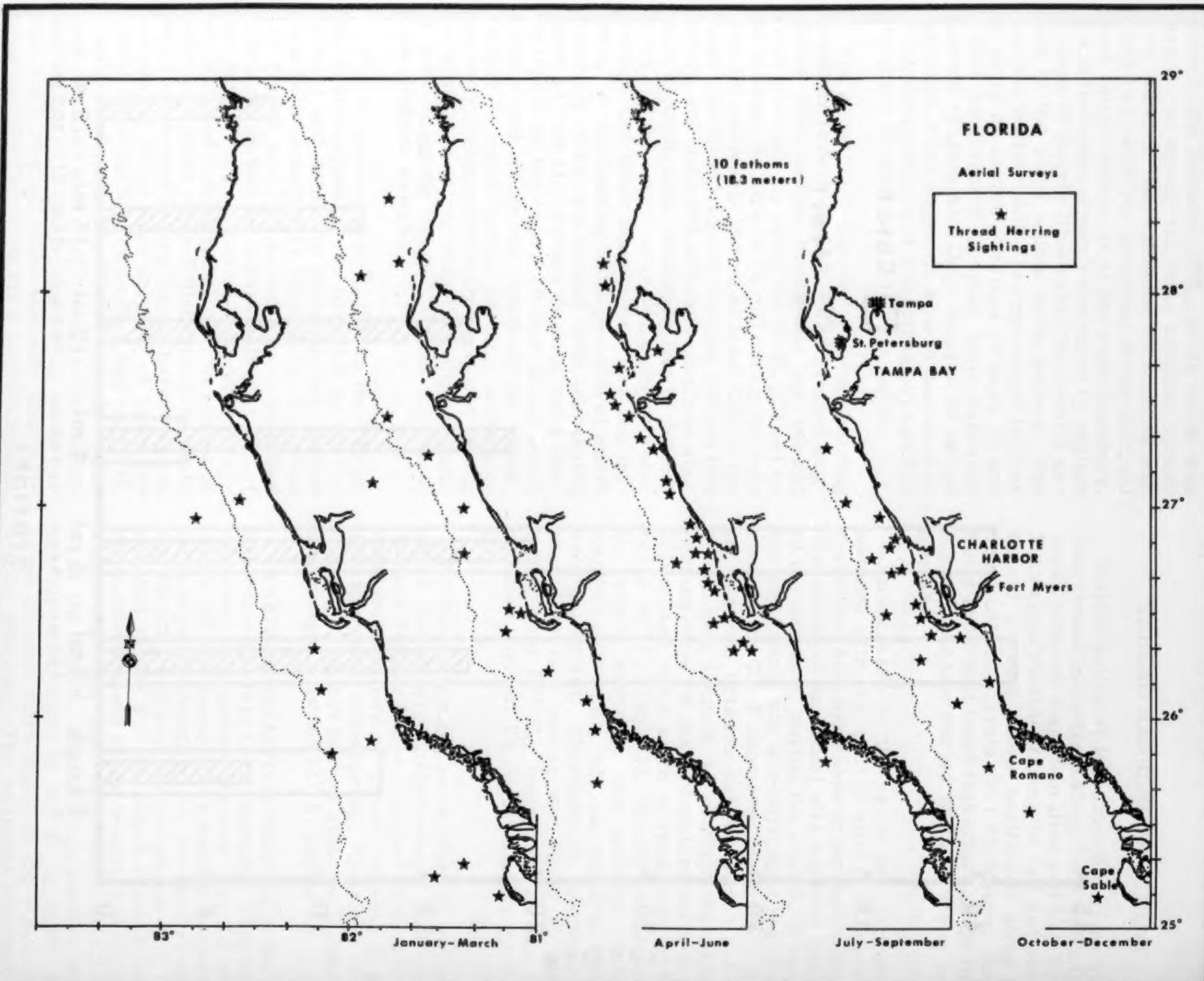

Fig. 3 - Seasonal distribution of aerial sightings of thread herring schools along Florida's Gulf coast.

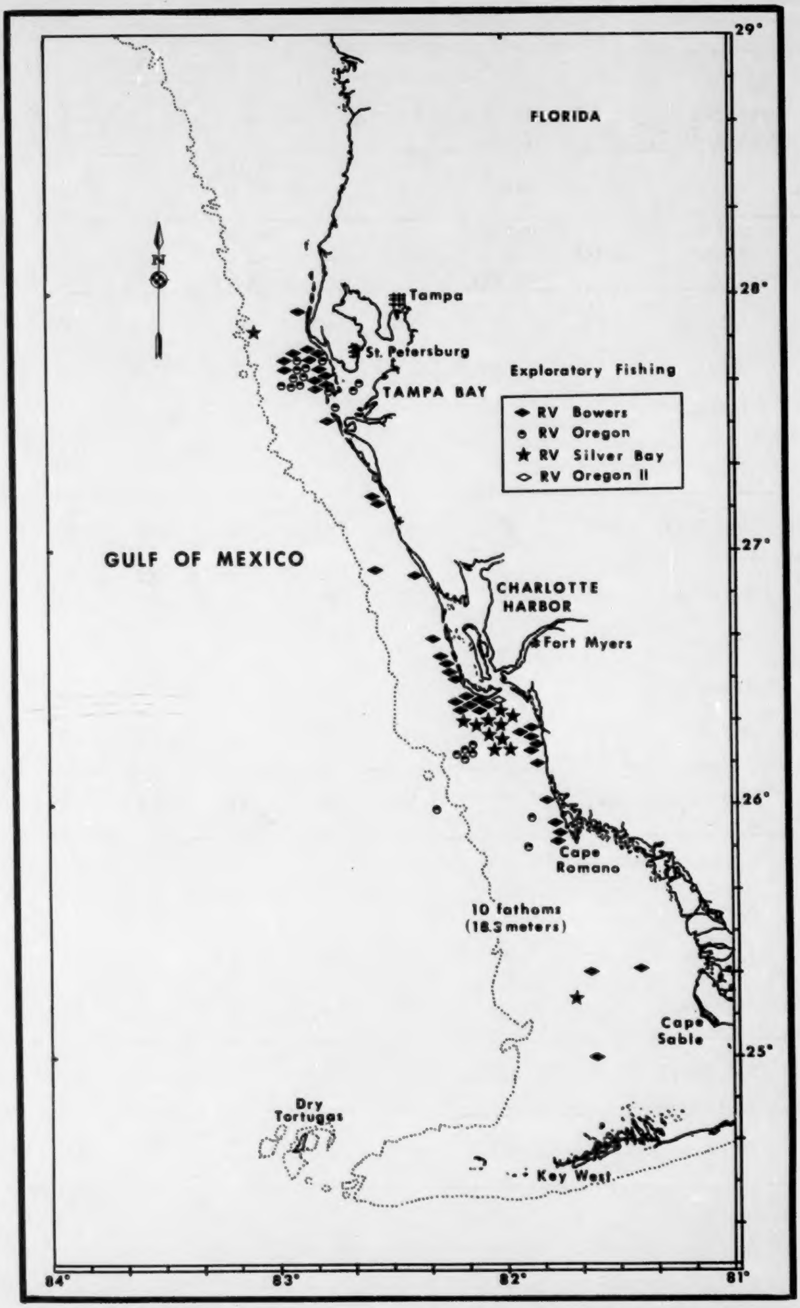

Fig. 4 - Distribution of exploratory catches of thread herring along Florida's Gulf coast.

Table 1.--Vertical distribution of thread herring by season along transect stations at depths of 25, 33 and 37 feet.

		STATIONS								
		3 miles			6 miles			9 miles		
	Season	Catch	Units of effort	C/E	Catch	Units of effort	C/E	Catch	Units of effort	C/E
Surface	Jul-Sep	56	4	14	169	4	42	34	4	9
	Oct-Dec	14	3	5	13	3	4	0	3	0
	Jan-Mar	8	3	3	25	3	8	0	3	0
	Apr-Jun	787	3	262	545	3	182	46	3	15
	Sub Total	865	13	67	752	13	58	80	13	6
Mid-depth	Jul-Sep	26	4	7	104	4	26	7	4	2
	Oct-Dec	14	3	5	14	3	5	0	3	0
	Jan-Mar	8	3	3	10	3	3	1	3	0
	Apr-Jun	195	3	65	172	3	57	0	3	0
	Sub Total	243	13	19	300	13	23	8	13	1
Bottom	Jul-Sep									
	Oct-Dec									
	Jan-Mar	7	1	7	28	2	14	0	1	0
	Apr-Jun				12	3	4	23	3	8
	Sub Total	7	1	7	40	5	8	23	4	6
	Total	1115	27	41	1092	31	35	111	30	4

Table 2.-- Thread herring catches and environmental observations at gill net stations in Tampa Bay.

	Station								
	Old Tampa Bay			Mid Bay			Bay Pass		
Date	C/E	Temp. °F	Sal. ‰	C/E	Temp. °F	Sal. ‰	C/E	Temp. °F	Sal. ‰
10-5-67	317	77.5	24.4	0	77.7	24.7	0	78.6	26.2
11-2-67	33	75.9	25.1	21	76.6	26.7	0	75.0	32.5
1-30-68				0	62.2	28.8	0	60.8	33.2
2-28-68	0	59.0	28.6	0	59.9	29.4	0	57.9	33.0
3-28-68	2	66.7	28.9	2	68.0	29.2	0	66.7	30.5
4-29-68				27	78.8	30.4	28	80.0	34.4
5-22-68	400	82.4	30.1	48	81.9	30.6	433	81.7	34.9
7-31-68	219	90.0	24.9	9	88.5	22.0			
8-21-68				0	89.2	24.0	16	88.5	32.9
10-31-68	0	71.6	22.0	4	70.3	25.0	3	68.7	32.5
1-23-69	0	60.6	23.8	0	62.4	25.2	0	60.8	31.6
7-10-69	125	88.2	27.0	1	89.4	28.5	1	89.4	35.3
9-24-69	2	83.8	22.0	0	83.8	23.4	2	82.9	33.3
Average	110	75.6	25.7	9	76.1	26.8	40	74.1	32.5

*C/E is catch per unit of effort with only one unit of gear fished at each station on each date.

Table 3.-- Thread herring catches and environmental observations at gill net stations between Sanibel Island and St. Petersburg, Florida.

Date	Area	Depth (feet)	Temp. (°F)	Salinity (‰)	Catch/effort*
8-23-67	Gasparilla Island	24	86.1	33.4	62
	Punta Gorda Beach	23	85.8	34.3	19
	Venice Inlet	23	86.3	33.8	2900 (est.)
4-17-68	Sanibel Island	30	74.8	34.8	138
	Sanibel Island	20	76.6	35.0	112
	Redfish Pass	20	77.0	35.1	3
2-7-69	Sanibel Island	19	64.2	34.3	0
	Redfish Pass	20	62.6	34.0	0
	Gasparilla Island	26	63.9	35.1	0
	Punta Gorda Beach	29	64.0	34.8	0
	Venice Inlet	29	63.9	34.8	21
11-25-69	Gasparilla Island	17	66.7	34.1	0
	Gasparilla Island	21	65.7	33.8	0
	Punta Gorda Beach	27	66.2	34.3	0
	Venice Inlet	28	66.0	34.2	0
	Sarasota	31	66.4	34.2	0
	Anna Maria Key	24	65.8	34.2	0

*Only one unit of gear was fished at each station on each date.

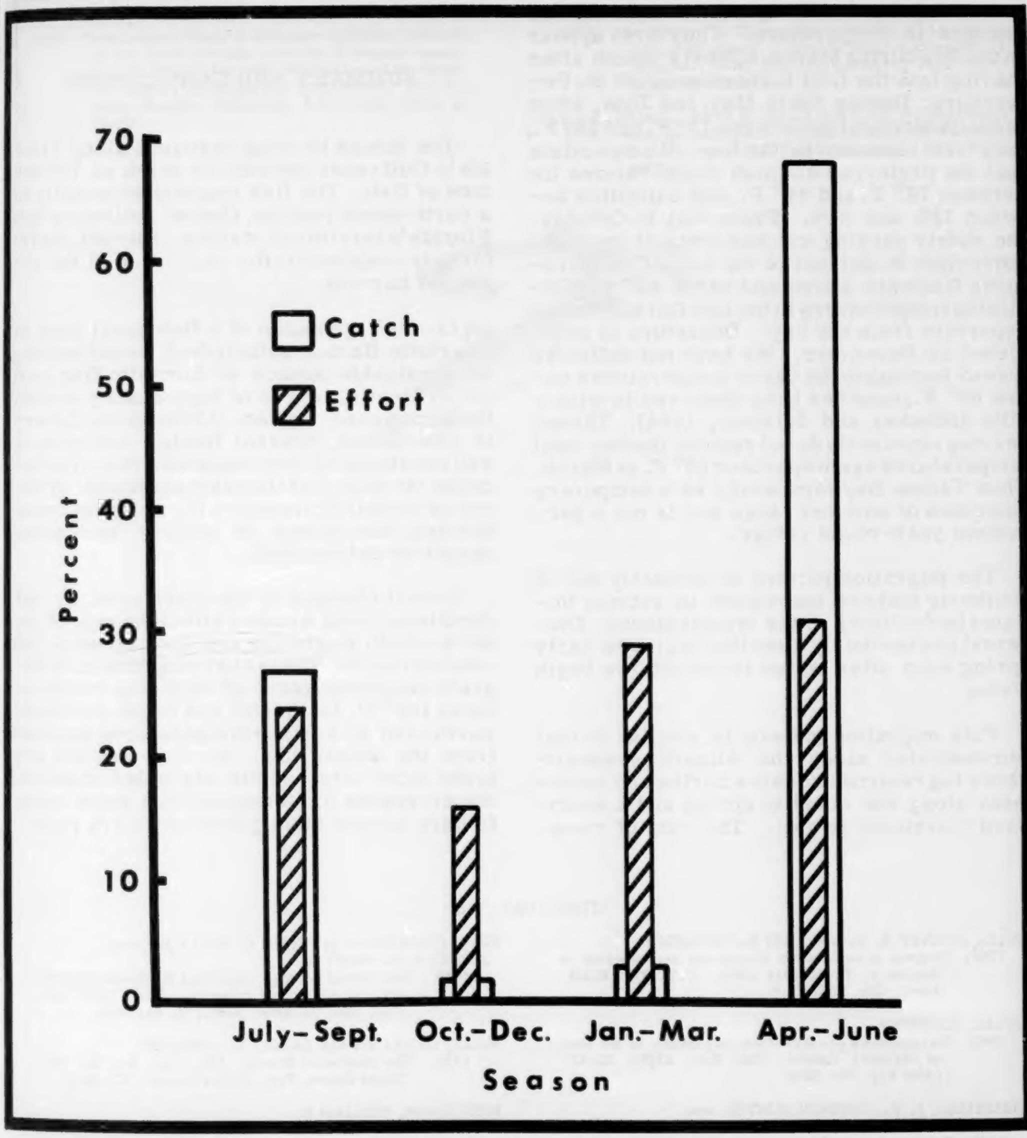

Fig. 5 - Seasonal percentages of total thread herring catch and total gill-net effort from all transect stations off St. Petersburg, Florida.

Although thread herring occur extensively in old Tampa Bay, their occurrence within the entire Bay system is governed by seasonal changes in temperature. They first appear in the Bay during March, almost a month after moving into the Gulf inshore zone off St. Petersburg. During April, May, and June, when temperatures range between 73° F. and 84° F., they are common in the bay. We speculate that the preferred summer temperatures lie between 79° F. and 84° F., and salinities between 32% and 34%. From July to October, the widely varying catches suggest sporadic movement in and out of the bay as temperatures fluctuate above and below 84° F. Declining temperatures in the late fall encourage departure from the bay. Departure is completed in December. We have not collected thread herring in the bay at temperatures below 66° F.; none has been observed in winter kills (Rinckey and Saloman, 1964). Thread herring apparently do not reenter the bay until temperatures again approach 68° F. in March. Thus Tampa Bay serves only as a temporary extension of summer range and is not a permanent year-round refuge.

The migration pattern is distinctly one of southerly inshore movement in autumn initiated by declining water temperatures. Dispersal in a northerly direction begins in early spring soon after water temperatures begin rising.

This migration pattern is similar to that demonstrated along the Atlantic seaboard, where tag returns indicate a northward movement along the coast in spring and a southward movement in fall. The rate of movement for thread herring along the Atlantic coast may exceed six miles per day. (Randall Cheek, NMFS Beaufort, N.C.)

SUMMARY AND CONCLUSIONS

The thread herring resource along Florida's Gulf coast contains as much as 750,000 tons of fish. The fish migrate seasonally in a north-south pattern, almost entirely within Florida's territorial waters. Florida, therefore, is responsible for regulation of the resource harvest.

Limited operation of a fish-meal plant in Charlotte Harbor established thread herring as a valuable source of domestic fish meal and a potential source of high-quality protein for human consumption. Although the fishery is now closed, present fishing restrictions will not stockpile this renewable resource because its size will fluctuate naturally. Without an economic incentive for studying thread herring, the causes of natural fluctuations cannot be determined.

Annual changes in the onset, severity, and duration of cold weather affect the rate of the north-south migration and the degree of fish concentration. Thread herring generally migrate south in advance of declining temperatures (68° F. isotherm) and begin movement northward as surface temperatures increase from the winter low. Because schools are found most often within six miles of shore, the prospects for a commercial purse seine fishery beyond state jurisdiction are poor.

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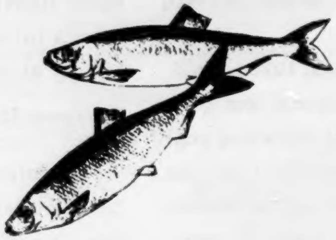

SEASONAL AND GEOGRAPHIC CHARACTERISTICS OF FISHERY RESOURCES

California Current Region - VI. Rockfish

David Kramer and Paul E. Smith

The purpose of this report on the rockfish resource, family Scorpaenidae, as for others in this series (Kramer and Smith, 1970a,b,c,d, 1971), is to describe the seasonal and geographic characteristics of their spawning populations on the basis of summarized data on the abundance of their larvae in the decade 1951-60. The organizations, area of investigation, and treatment of the data were presented in the first report of the series.

The rockfishes of the northeast Pacific are of major importance in the commercial and sport fisheries of the United States (Phillips, 1957, 1958). The family consists of so many species, most of them in the genus Sebastes, that they are usually grouped only under the common name "rockfish" in the commercial landing reports of the State of California. The family consists of three genera, of which Sebastes has at least 55 species; Sebastalobus has two species, and Scorpaena one. In California, three species of Sebastes comprise the major portion of the commercial catch of rockfish for human consumption, about six species form the greatest part of the animal food fishery, and two contribute chiefly to the sport fishery. The single species of Scorpaena contributes to both the commercial and sport fisheries. The California fisheries and others in the northeast Pacific are described briefly at the conclusion of this report.

Sebastes Most Abundant Genus

The most abundant genus in the rockfish larva collections of the California Cooperative Oceanic Fisheries Investigations (CalCOFI) is Sebastes which, until recently, has been enumerated only as "rockfish", with no differentiation to species. Our knowledge of adult spawning, therefore, is based on total rather than individual species distributions. Some species, and the times and locations of their spawning, are discussed below.

The rockfish family in the northeast Pacific extends from the Gulf of Alaska to Baja California (Phillips, 1957; Ahlstrom, 1961). The CalCOFI surveys have delimited the distributions of rockfish larvae to their southernmost extent and offshore off almost all of Baja California as indicated in the figure. They have not delimited the populations seaward off California nor in their northernmost extent where, in the limits of the surveys, they have been found as far offshore as 250 miles and as far north as the California-Oregon border.

The authors are Fishery Biologists, NMFS Fishery-Oceanography Center, 8604 La Jolla Shores Drive, P.O. Box 271, La Jolla, California 92037.

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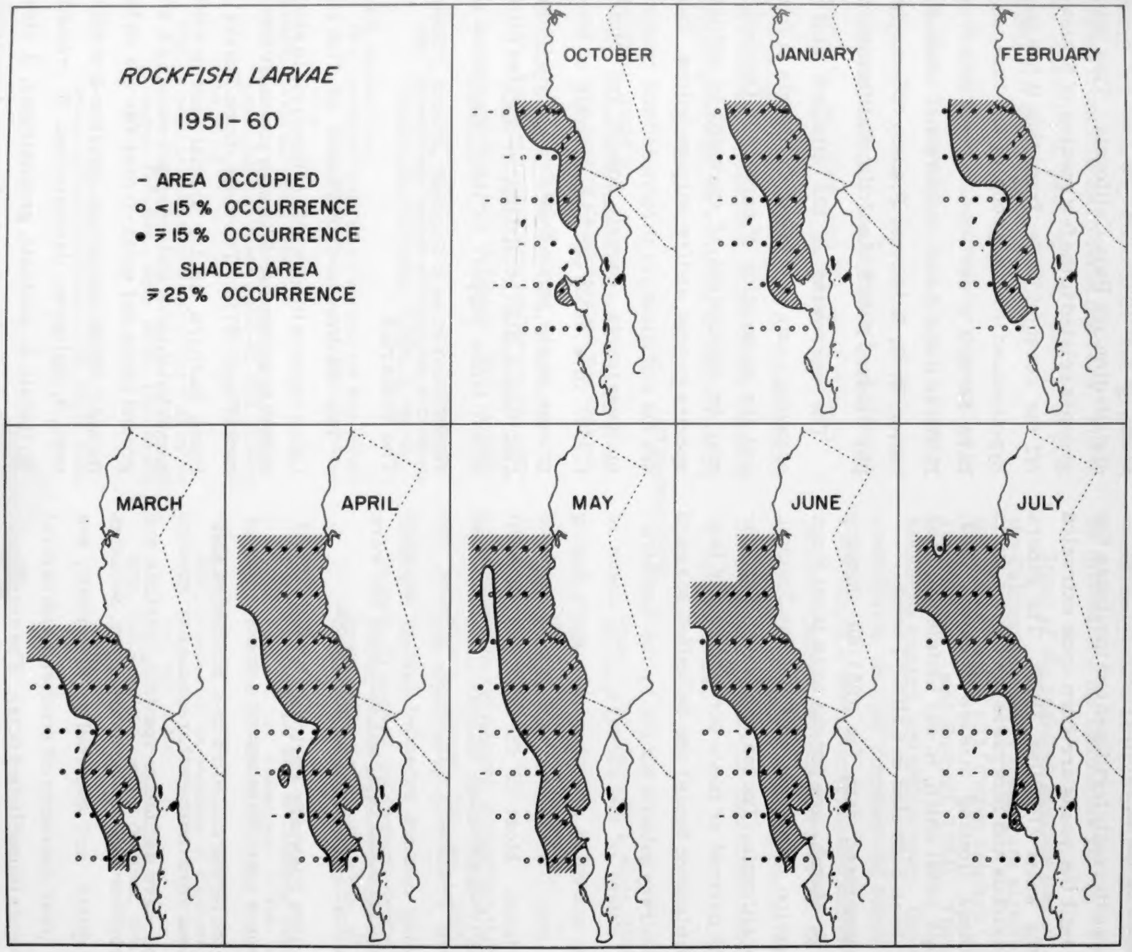

Percent occurrence of rockfish larvae, Sebastes spp. in 1951-60 on the survey pattern of the California Cooperative Oceanic Fisheries Investigations (CalCOFI). Each circle, line or dot represents a pooled statistical area (see Kramer and Smith 1970a).

Plankton data on rockfish are for larvae only. Their eggs are not planktonic because the genus Sebastes is ovoviviparous--the female is externally fertilized and incubates the eggs until the young are born upon extrusion into the water (Phillips, 1958). The genera Sebastalobus and Scorpaena lay their eggs in gelatinous floating masses (Pearcy, 1962; Phillips, 1958) which, to our knowledge, have never been collected in CalCOFI tows.

Summarized data for 1951-60, January through March, are for the area from Point Conception, California, to Point San Juanico, Baja California. The major centers of spawning (25 percent or more occurrences of larvae in plankton hauls) are delimited seaward in the survey pattern but not by the northernmost extent of the surveys. The areas of major spawning are about the same during those months with a slight spread seaward with time. Most of the surveys in April through July extended northward to the areas off San Francisco. In these months, the spawning centers extended farther seaward off southern and central California but were not delimited seaward or northward.

Definitive Spawning Periods

Recent identifications of some species of rockfish larvae collected on a number of CalCOFI surveys indicate that species or species groups have definitive spawning periods and geographic ranges. The chilipepper, Sebastes paucispinis, and shortbelly, S. jordani, are early-year spawners off southern and central California (unpublished data). The coral-red, S. macdonaldi, is a spring spawner with greatest numbers occurring off Baja California from Cape Colnett to Punta San Juanico (Moser, in press). The rosy, S. rosaceus group, is a summer spawner with a southern distribution off Baja California. This latter group is related to the few species of Sebastes off the coast of Chile; from this it has been hypothesized that the group, at one time, may have formed a continuous population from North to South America (personal communication, E. H. Ahlstrom, Fishery-Oceanography Center, NMFS, La Jolla, California).

The narrowing of the offshore band of spawning centers off Baja California in July, and the separation of centers in October[1], may be indications of spawning by species, species groups, and/or subpopulations. Data are not sufficient yet to form definite opinions on these points. Barrett, Joseph, and Moser (1966) in a study on the analysis of blood groups of the genus Sebastes (= Sebastodes) clarified a differentiation of species pairs which lends support to their distinction as species.

The Fisheries

The California Department of Fish and Game reports three kinds of fisheries in which different species of Sebastes are most dominant (Frey, 1971). The first, from Eureka to Santa Barbara, is for animal food in which unmarketable, trawl-caught rockfish are ground whole and quick-frozen for use on fur farms. Their important species are splitnose, S. diploproa, darkblotched, S. crameri, stripetail, S. saxicola, greenstriped, S. elongatus, sharpchin, S. zacentrus, and greentail, S. chlorostictus.

[1]Data for August, September, November, and December are insufficient for summarization to depict the trends shown in the figure.

The second is the commercial fishery for fresh food to which only three species, caught chiefly by trawl, contribute the greatest catches from Eureka to Santa Barbara. These are bocaccio, S. paucispinis, canary, S. pinniger, and chilipepper, S. goodei.

The third is the sport fishery dominated by the blue, S. mystinus, and olive, S. serranoides. The sculpin, Scorpaena guttata, contributes abundantly to the fresh food fishery, chiefly by set lines, and the sport fishery.

Although little is known about the status of the rockfish populations, most of the catches remain good with no evidence of reduction by any particular pressures. The California Department of Fish and Game estimates that a sustained yield of 15 to 20 million pounds could be maintained off California (Frey, 1970).

Some of the rockfish species important to the California fishery also figure significantly in the Washington and Oregon catches (Alverson, Pruter, and Ronholt, 1964). These are boccacio, canary, and chilipepper. The major contributor in that commercial catch is the rockfish, S. alutus, marketed as Pacific ocean perch. Others include blackthroat, S. aleutianus, silvergray, S. brevispnis, yellowtail, S. flavidus, black, S. melanops, and flag, S. rubrivinctus.

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LIVE CARS FOR USE IN CATFISH INDUSTRY

Donald C. Greenland, Robert L. Gill,
& James C. Hall

Live cars--mesh "fish-holding bags"--have a variety of applications in the production of pond-raised channel catfish (Ictalurus punctatus). When used in harvesting and holding catfish, the fish can be moved easily to loading sites or shifted to safe areas for holding. When used along with a haul seine, pulling techniques are modified so the seine forms a "chute" during the final stages of seining. This is necessary to encourage fish to move into the live car.

Information on holding capacities and a method to accurately meter fish into live cars are needed by fish farmers to better utilize these units. As more data are developed on live car holding capacities, and new applications found, live cars will be accepted as useful tools in catfish farming.

Live cars are finding acceptance as useful harvesting and management tools by fish farmers producing pond-raised channel catfish (Ictalurus punctatus). Farmers are discovering that these mesh "fish-holding bags" described by Boussu (1967) are very helpful in harvesting, handling, and loading channel catfish; these bags are useful too in working with fish in other phases of their farming operations. Research has continued on the live car's development at the Kelso Station, Arkansas. More information is available on its application, construction, and operation.

APPLICATION

There are many ways catfish producers can use live cars. They can be coupled with a seine and used as collection bags for the catch. Full live cars can be moved around a pond to a point suitable for loading. They can be shifted to deep water, or set adjacent to a well head for holding fish. Haul trucks can be scheduled more accurately because fish in properly staked live cars do not escape and can be harvested before truck arrives. Exact quantities of fish can be placed in live cars and held for future loading; the unneeded fish can be returned to the pond. Loading is simplified because fish can't escape by swimming under the seine; boom-mounted brailers can be lowered into the live car and filled by crowding fish into them, thus eliminating time-consuming dip-netting. Workers can stand outside the live car to load fish and are much less likely to get "finned". Live cars can be used to hold small quantities of fish for processing--or be used during sorting as repositories for selected fish. We expect many more uses will be discovered as the live car becomes a working tool in fish farming.

LIVE CAR USE

The live car, coupled with a haul seine, makes a very effective unit for harvesting catfish from well-constructed commercial farm ponds (Figure 1). We have used this arrangement in ponds ranging from 3 to 40 acres and have captured up to 78,000 pounds of channel catfish in one seine haul by using several live cars in sequence. Harvesting efficiencies in well-constructed ponds using live cars and haul seine have been as high as 90%.

In our studies, we used the mechanized haul seine and equipment described by Coon, Larsen, and Ellis (1968). Here the live car was attached by a coupling ring to a specialized

Mr. Greenland is a Fishery Biologist and Mr. Gill is Fishery Methods and Equipment Specialist, National Marine Fisheries Service, Kelso, Arkansas.
Mr. Hall is Vice President, Foods Multinational Ltd., Bank of America Building, San Pedro Sula, Honduras.

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"funnel" section positioned somewhere near the middle of the haul seine (Figure 2). The specialized section forms a transition between seine and live cars. It has a 10-foot-square opening at the seine and necks down to a 2-foot-high by 4-foot-wide port at the back end. All the transition takes place on the sides and the top so the bottom can remain flat on the pond bottom when being fished. The basic design of this "funnel" section takes advantage of the bottom-seeking behavior catfish demonstrate in their escape attempts during seining.

Several sizes and shaped for the opening between the funnel section and live car were tried. We found a 2-foot-diameter round opening unsatisfactory because most of the open area is off the bottom--and thus contrary to fish behavior. Also, the 2-foot-diameter hole is not large enough to give a satisfactory flow of fish. This is also true with a 2-foot-square opening. In large ponds, with the seine moving at 25 to 30 feet per minute, the orifice size must be large enough to allow fish to pass into the live car as the seine is being beached or the fish will be beached. A 4-foot-wide opening is about the minimum width desirable. The height of the opening is dependent upon water depth. For example, if the pond is three feet deep where the live car is used, a 3-foot-high opening would be fine. However, if the pond is 2 feet deep, a 2-foot-deep opening is adequate. A 2-foot-high by 4-foot-wide coupling ring was used in most of our tests. Draw strings in both the funnel section of the seine and in the live car are tied tightly around this coupling ring to fasten the two units together.

In most instances, we wait until about $\frac{2}{3}$ to $\frac{3}{4}$ of the pond is pulled before tying on the live car. This eliminates the possibility of tearing the unit on obstacles, such as roots or snags. Also, if the pond has a soft, muddy bottom, the seine is a little easier to pull without the drag of a large live car. The coupling ring is tied in the live car on shore and, at the appropriate time, carried out and tied to the funnel section of the seine. This can be done on foot or by boat. We use a short piece of twine to tie off the end of the funnel until the live car is attached. The funnel draw string could be used but is hard to untie when it is wet; it is easier to just cut the twine tie.

A different pattern of beaching the seine is used when a live car is attached. As soon as possible, usually when both ends of the seine are about ready to be beached, we start setting up a "chute". Figure 3 illustrates this maneuver. The narrower the "chute", the easier it is to get fish to enter the live car. There is much less space for them to mill in and a more directional impetus for them to move into the live car. With large quantities of fish, it will be necessary to stop pulling the seine occasionally and let fish pass into the live cars. In most cases where the "chute" is established in time, it will be necessary to roll only a few hundred pounds out of the seine into the live car as it is beached. Without setting up a "chute", however, there may be many thousands of pounds of fish remaining in the seine as it is beached; it is just about impossible then to move these fish into the live car.

Capturing large quantities of fish in live cars can be handled in different ways. Several small live cars can be used; as each is filled, it is removed and an empty one attached. In a test on a 40-acre pond, we made eight live car changes. We have attached two live cars in tandem (Figure 4), allowed fish to pass through the first into the second, and removed the second one when full.

Once filled, live cars should be staked as soon as possible (Figure 5) to prevent fish from escaping. The stakes should be set so there is about one foot of freeboard on the live car. To do this requires a stake every eight feet or so. Proper staking will prevent fish from escaping over the cork line if it is submerged by turtles, or by the weight of the catch.

If the live cars are to be positioned near a pump discharge, place them so the eddy caused by the discharge creates circulation through the mesh sides of the live car. Don't put them directly under or in front of the discharge. Over a period of time, strong currents can cause stress and result in fish mortality.

If the live car appears to be very heavily loaded, the population pressure can be relieved by attaching a second live car to the first; over several hours, the population will equalize.

CONSTRUCTION

In general, the live cars and specialized seine sections can be made of any material suitable for seines. We used live cars made of one inch bar measure, number 18 nylon

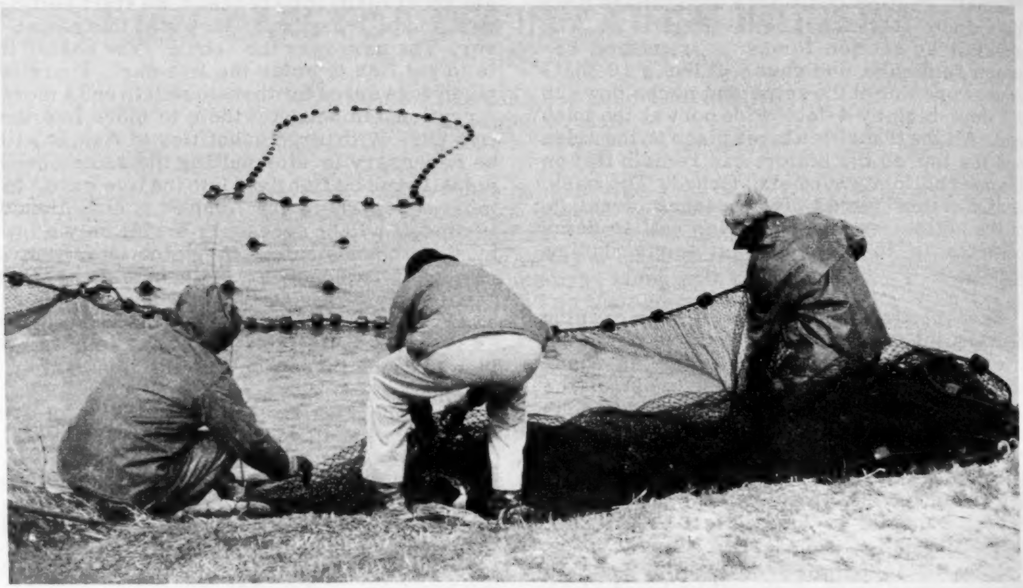

Fig. 1 - Harvesting channel catfish from a 20-acre pond using a haul seine and live car.

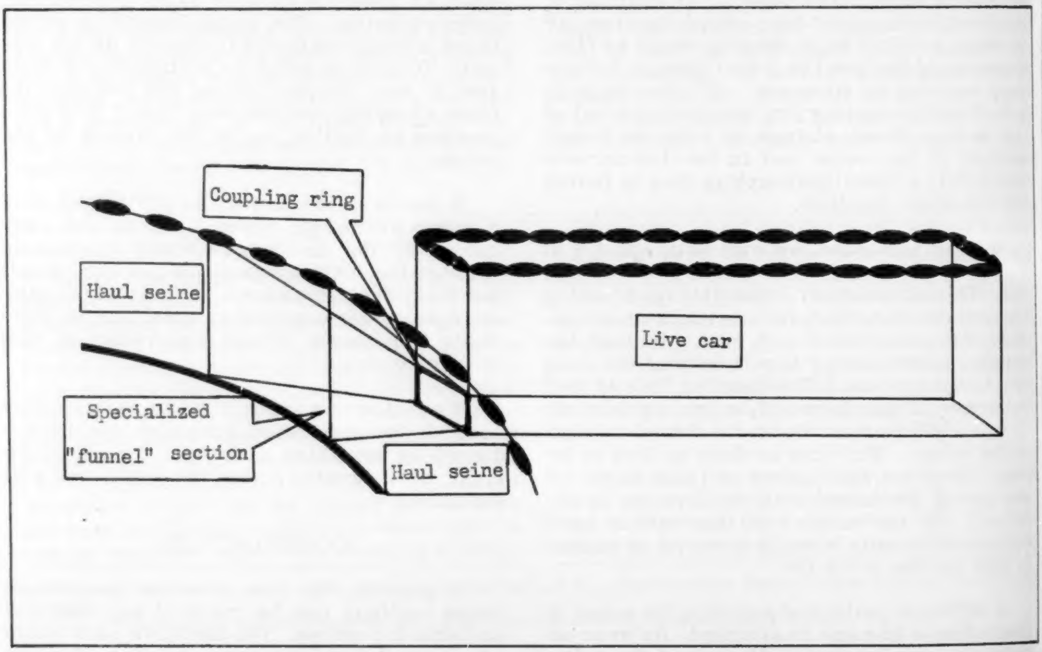

Fig. 2 - Diagrammatic sketch of specialized "funnel" section and live car rigged into a haul seine.

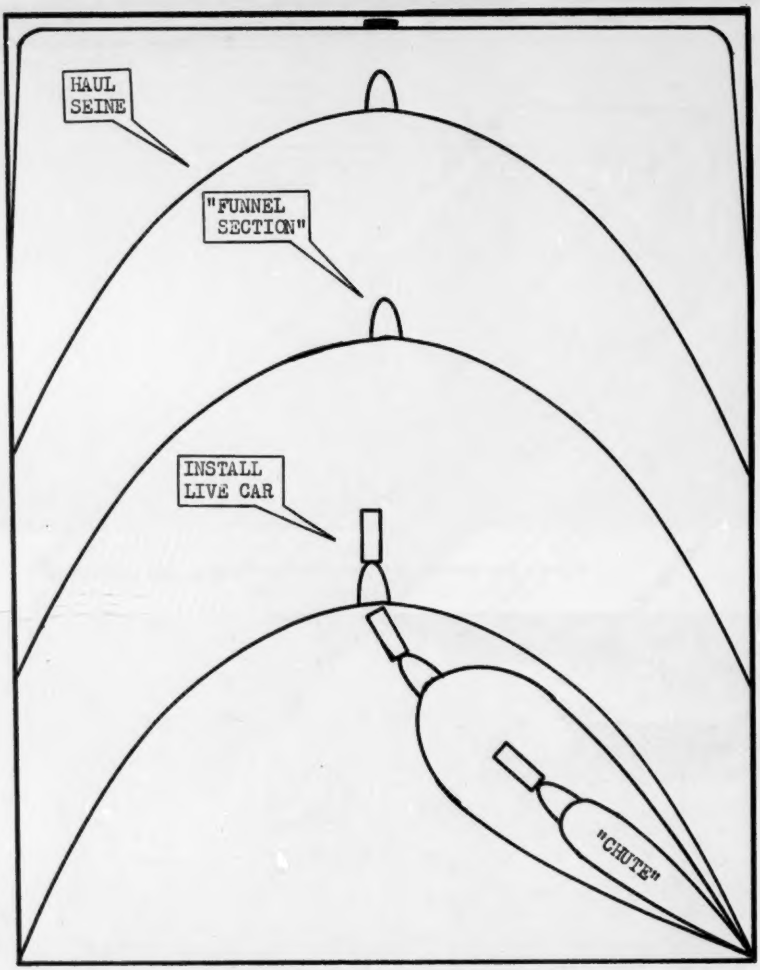

Fig. 3 - Schematic drawing of haul seining procedure used with live car.

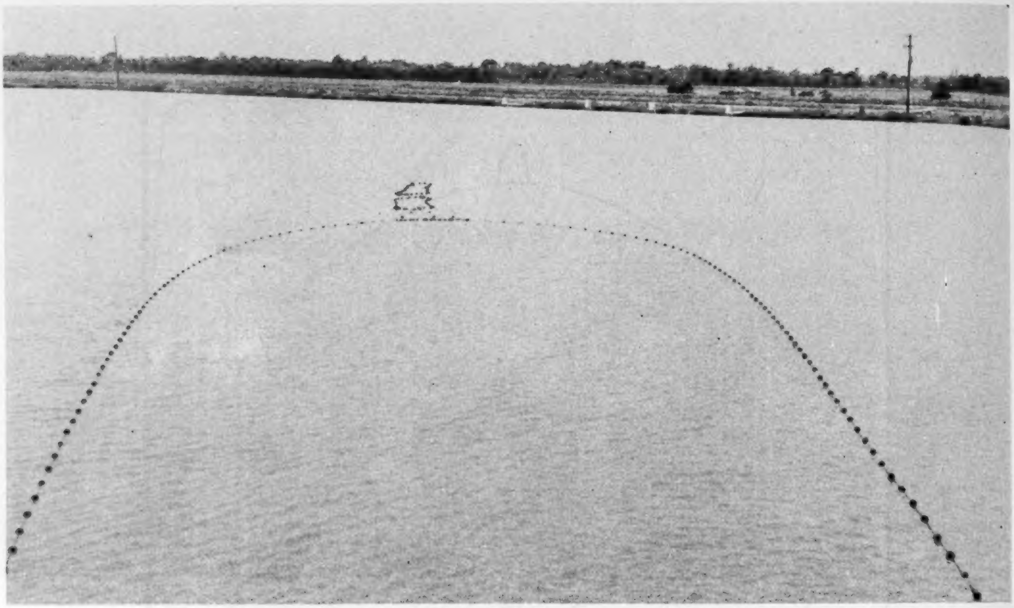

Fig. 4 - Live car used in tandem during harvesting.

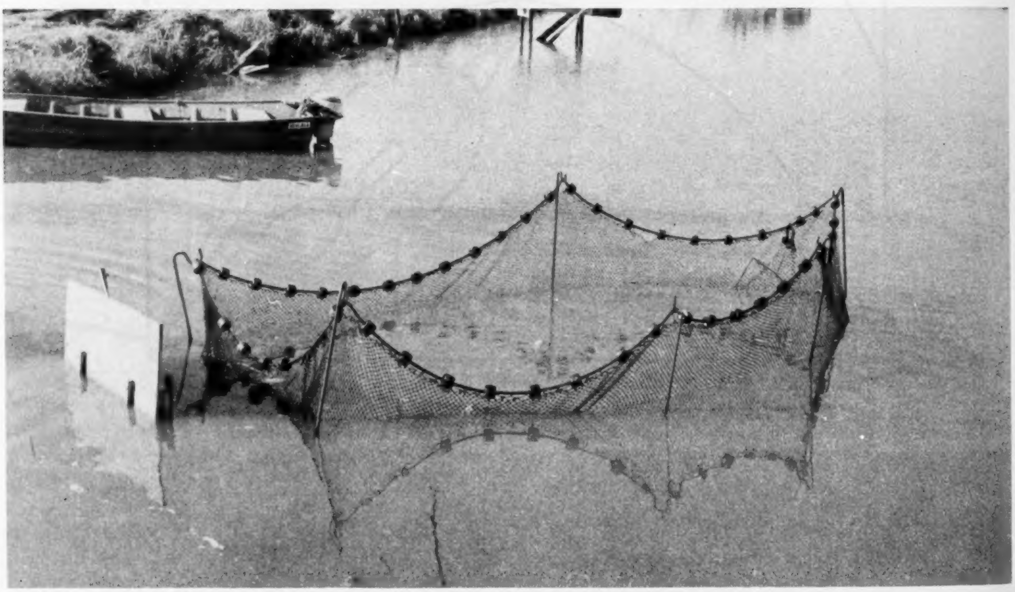

Fig. 5 - Test live car staked for holding fish.

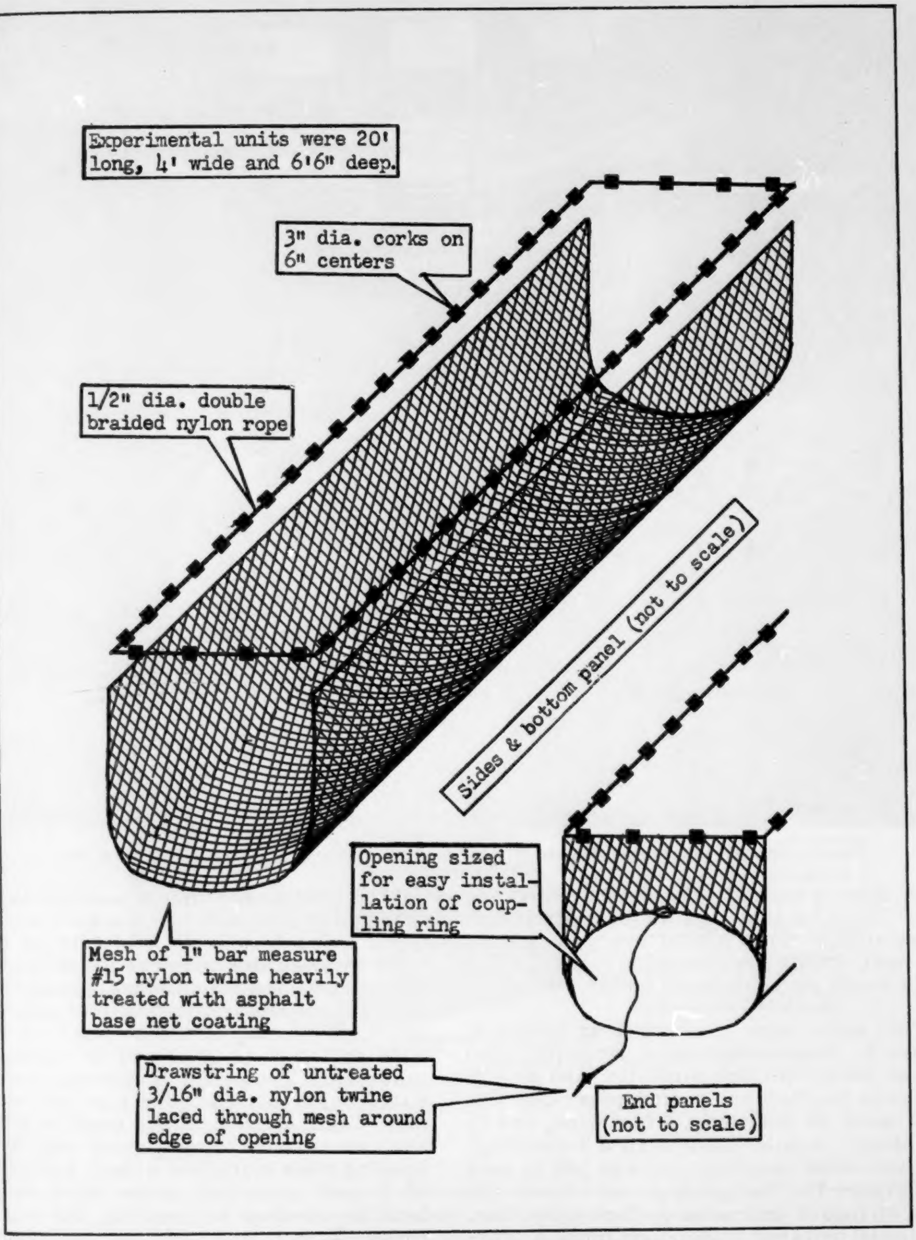

Fig. 6 - Construction details of experimental live car.

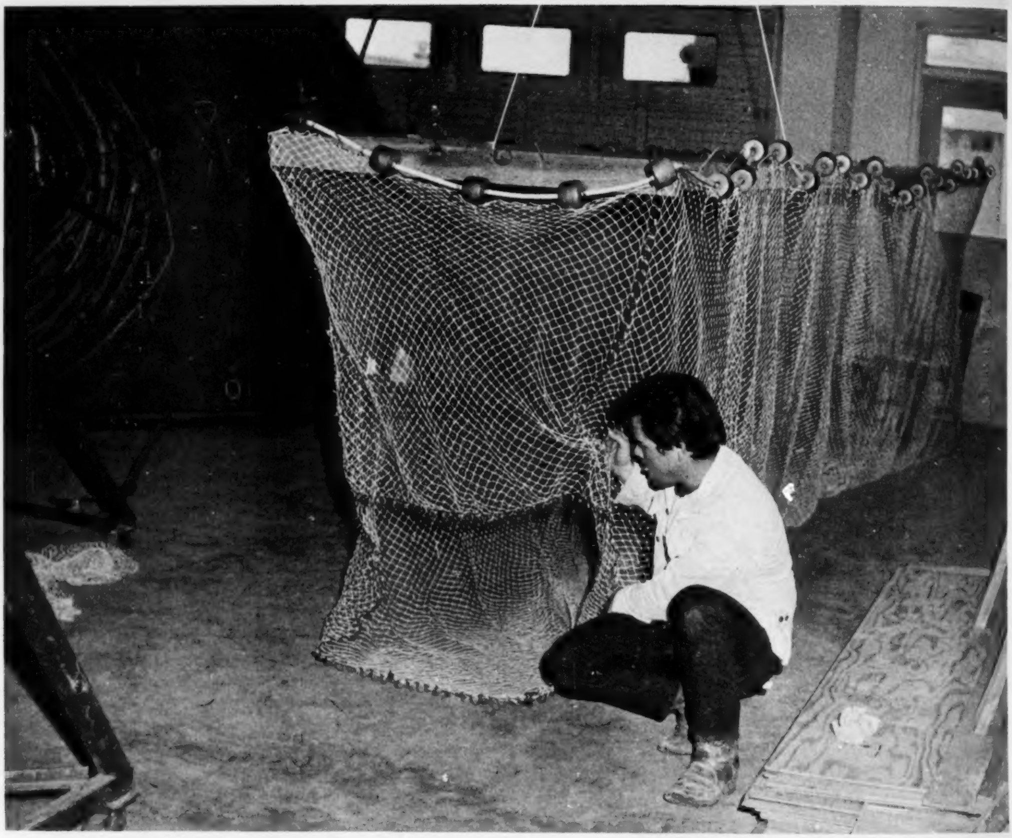

Fig. 7 - Live car in final stages of construction showing 2 by 4-foot-wide opening left for coupling ring.

twine, heavily treated with an asphalt base net coat. The cork line consists of $3\frac{1}{2}$-inch diameter sponge corks placed every six inches on $\frac{1}{2}$-inch double braided nylon rope. Larger corks would probably work better.

The units were assembled as shown in Figure 6. Dimensions vary depending upon size of ponds, the fish population and size of fish to be handled, and pond depths. Our test units were 20 feet long, 4 feet wide, and $6\frac{1}{2}$ feet deep. A hole sized to fit a 2-foot-high by 4-foot-wide coupling ring was left in each end (Figure 7). The openings were fitted with draw strings of untreated $\frac{3}{16}$-inch nylon line. Our initial units had 2-foot-long tunnels leading from the coupling ring to the live car. We found the tunnel unnecessary; in fact, it seemed detrimental to fish passage.

The specialized funnel section was constructed of one-inch bar measure number 18 nylon twine heavily treated with an asphalt base net coat. Its construction is illustrated in Figure 8. The height of the opening depends on the seine depth--for an 8-foot seine, an 8-foot-high opening would be used. A 4-foot-wide exit port is used and is considered a minimum. The height of opening depends on water depth but should not be less than two feet. Corks are tied to rope panel of funnel to keep panel from bagging back into live car opening when in shallow water. A draw string of $\frac{3}{16}$-inch untreated nylon twine is woven into the meshes surrounding the exit port. Lines, $\frac{3}{16}$ inch, are laced into net seams and around entrance opening to add strength to this unit. This is done because it is often necessary to lift and roll several hundred

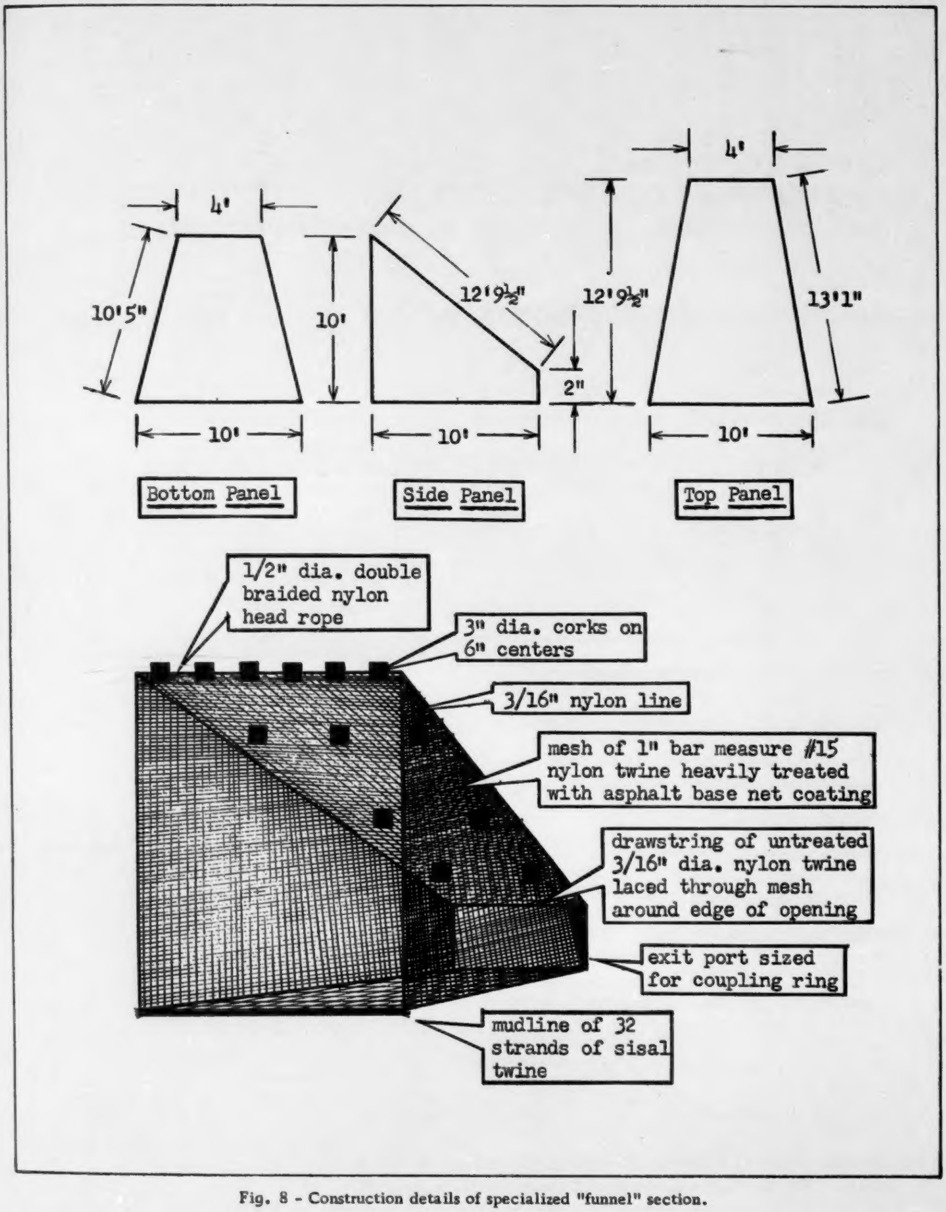

Fig. 8 - Construction details of specialized "funnel" section.

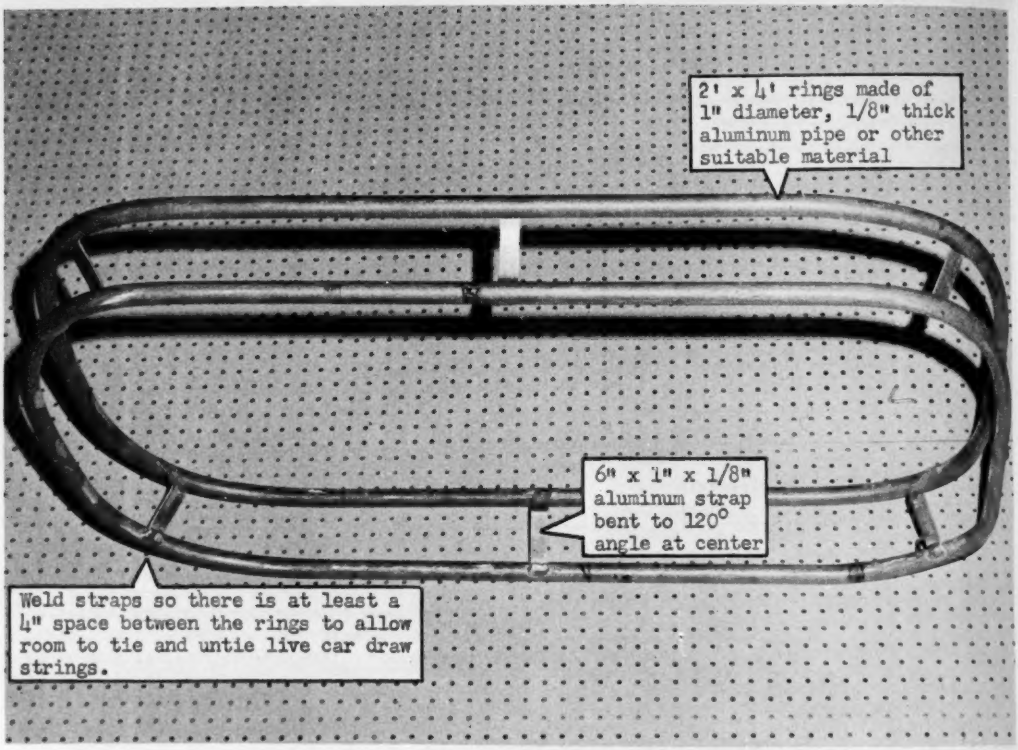

Fig. 9 - Construction details of live car coupling ring.

pounds of fish through the funnel in the final stages of harvesting.

The details of the coupling ring are shown in Figure 9. The two main rings must be wide enough apart to allow hand access for tying and untying the draw strings. The angle of the cross braces is necessary to give a trough deep enough to keep the funnel section and live cars from pulling off. It is helpful to have more than one of these rings so additional live cars can be made ready while one is still fishing.

FISH CAPACITIES OF LIVE CARS

The fish capacity of a live car is dependent upon such factors as live car size, pond water depth and temperatures, length of time fish are to be held, and whether a well discharge or a circulating pump is available. When harvesting using a live car 20 feet long by 4 feet wide by 6.5 feet deep, between 8,000 and 12,000 pounds of channel catfish can be crowded into the live car. If the water temperature is below 60° F., this amount could be held many hours in this live car without problems. If the water temperature were in the low 80s° F., they should be held only a short time and be watched constantly. If a long holding period is anticipated, the population should be spread out into more live cars.

In all holding situations, it would be beneficial to move the fish to deeper water to give them more water room and to get them out of the muddy and roiled harvesting area. Holding times can then be lengthened. It is also good insurance to position live cars so pond water supplies or recirculating pumps could be used if the need arises.

FISH FARMERS' CONCERNS

Almost all the fish farmers we talked to about using live cars have expressed concern about the lack of hard facts on holding capacities. Until information on holding

accumulates, we advise that if any concern arises that the live car is too heavily loaded for pond conditions, a man should be stationed to watch the live car. If fish start piping or rolling, or there are other indications of developing problems, a relift pump can be turned on, a well started, or the fish can be dumped from the live car back into the pond.

Some farmers have experienced difficulty in using live cars in ponds with soft, muddy bottoms. If live cars are allowed to sit in one place too long, or units are put into pond with seine the day before harvesting, they can "mud in"--the mesh on bottom will sink gradually into the mud. In ponds with muddy bottoms, live cars also can cause drag and make seine harder to pull. Usually, these problems can be eliminated by waiting until near end of seine set to instal thelive car. In fact, at this stage of seining, the drag of a live car is helpful as an anchor in holding the middle of the seine as "chute" is set.

Channel catfish are very adept at escaping from confined situations. Many fish farmers have had the experience of bunching up several thousand pounds of catfish in a seine one day--and coming back the next day to find them gone. Live cars are much more secure for holding fish than seines but, if there are any holes or if the cork line is not properly staked, fish will escape. The live car should be examined for holes every time it is used, and all holes should be patched. Extra minutes spent checking the live car and staking it properly may save reseining a pond.

A means of estimating how many fish or pounds of fish are present in a live car is needed. Some device or method that could measure the flow of fish into the live car and give fish quantities at any time would be useful. At present, a visual estimate is used; our experience shows the amount can be off as much as 100%.

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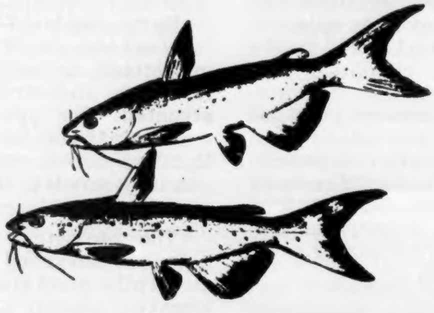

FISH PROTEIN CONCENTRATES

George M. Knobl Jr., Bruce R. Stillings,
William E. Fox, & Malcolm B. Hale

Fish protein concentrates have been used in various parts of the world for several centuries. It has only been within the past 30 years, however, that the production of FPC has been investigated on a scientific basis.

Today several pilot plants and full-scale industrial plants have been built. Most of these plants produce FPC by solvent (usually isopropyl alcohol) extraction procedures.

The FPC's produced are, in general, bland tasting and vary in color from white to dark tan. They contain between 75 and 95 percent high-quality protein and they exhibit limited functional properties according to standards set by industry for high protein foodstuffs. The characteristic of limited functional properties far from being a drawback, is in many circumstances advantageous since FPC can be added to existing food products, markedly improving the nutritional quality without significantly altering other characteristics, although in some instances the addition appears to improve the shelf life of final baked products.

One must not assume, however, that all solvent extracted FPC's nor even all isopropyl alcohol extracted FPC's, are completely alike. On the contrary, significant differences in odor, lipid content, stability, taste, nutritional value, and functional properties are obtained depending upon the processing conditions and the species of fish used.

Experimental work is now being conducted to produce FPC with various solvents, and with enzymes, microorganisms, or combinations of enzymes and solvents. The products resulting from these processes have improved functional properties. Some of these appear to be particularly promising for use in certain foods because of their functional attributes.

Although many problems still remain to be solved and additional research is required to show how FPC can be utilized more efficiently, an FPC industry has been started.

INTRODUCTION

Fish protein concentrates (FPC's) are defined as those products obtained from fish in which the protein is more concentrated than the original raw material. FPC's may range from light-colored, bland powders to dark powders having intensely fishy tastes, or they may be pastes with a similar wide range of colors and tastes. Both powders and pastes may be water soluble or insoluble and may be high in nutritive value or only intermediate in nutritive value.

FPC's may be prepared by a variety of methods most of which can be classified as chemical (solvent extraction) or biological (enzymatic and microbial) procedures.

During the last 20 years most efforts have involved the use of solvents, usually isopropyl alcohol, and several pilot plants and a few full-scale industrial plants have been constructed. The type of FPC produced by solvent extraction is a bland, nearly odorless, lightly-colored, water-insoluble but highly nutritive powder, intended for use as a protein supplement.

The biological procedures, in general, have not advanced beyond the laboratory or small pilot plant stage. The FPC's produced, however, usually have more desirable functional characteristics than the solvent produced FPC's. That is, in addition to having good nutritive properties, they have other attributes, such as water solubility, which may lead to wider market appeal.

If FPC's are to be widely used, markets must be defined; therefore, marketing studies have been conducted.

Dr. Knobl is Research Director, Dr. Stillings, Supervisory Research Chemist, Mr. Fox, Experiment & Demonstration Plant Program Coordinator, & Mr. Hale, Research Chemical Engineer, College Park Fishery Products Technology Laboratory, National Marine Fisheries Service, Regents Drive, University of Maryland Campus, College Park, Maryland 20740.

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This paper reviews the resources available to make FPC, the laboratory and pilot plant solvent extraction and enzymatic procedures under investigation at the Fishery Products Technology Laboratory at College Park, Maryland, commercial procedures for making FPC's, the characteristics of the FPC's produced, and the potential domestic and foreign markets for FPC's.

The use of FPC as a new source of protein depends upon the fish supply. Before an industry can be started, a continuing supply of raw material must be available. The growth of world fisheries in the last 100 years has been remarkable. The world catch rose from 2 million metric tons in 1850 to 64 million metric tons in 1968. However, questions have been raised regarding the future growth in landings and the maximum annual sustainable yield that can be realized.

Many scientists have occupied themselves with predicting the potential maximum sustainable yields of fish that can be harvested from the sea. The estimates vary widely and should only be regarded as indications of the magnitude of the resource.

Kastavan and Holt (1) concluded that an annual harvest of 500 million metric tons was a reasonable estimate of the potential sustainable annual harvest. This estimate was based on the primary organic production in the sea.

Chapman (2) estimated a much higher annual yield based on the carbon that is fixed annually into living matter in the ocean. He concluded that 2 billion metric tons of fish are available annually that are "large enough and useful enough to form the basis of practical commercial harvest."

More recently, a consideration of 17 estimates led Shaeffer and Alverson (3) to conclude that a sustainable world potential existed for 180 million metric tons annually with foreseeable extensions of present harvesting techniques. A Panel on The Commission on Marine Science and Engineering and Resources arrived at a similar figure and concluded that if fishing were broadened to include other species, locations, and equipment than those presently used, annual production could be realistically expanded to 400 to 500 million metric tons before expansion costs became excessive. Even further increases might be achieved given significant technological breakthroughs in the ability to detect, concentrate and harvest fish on the high seas and in the deep ocean.

Although these estimates vary widely, they do indicate that the amount of food in the sea that can be used to alleviate the dearth of food on the land is indeed sizable. It is obvious, however, that there is not an unlimited supply of fish in the ocean and careful judgment must be exercised to ensure wise use of the resource.

Obviously, the majority of the harvest will continue to be used in traditional forms, such as fresh and frozen fish, and fish meal. However, there is a large unutilized resource that could be processed into FPC.

PROCESSING

Research

Chemical Methods.--Chemical methods use solvents to remove water and lipids from fish. The primary purpose in removing water and the highly reactive lipids is to produce a stable and organoleptically acceptable product for human consumption. Numerous chemical methods have been developed in various parts of the world to produce FPC. References to most of these methods are given in a recently compiled Bibliography published by the Library of Congress (4). Among the chemical methods developed are those of the following groups: VioBin Corporation, General Foods Corporation, Lever Brothers Company, United Nations, Canada, Fishery Research Institute of South Africa, and Astra of Sweden.

In 1961, the U.S. National Marine Fisheries Service (formerly the Bureau of Commercial Fisheries) began a research program to investigate various methods of producing FPC. Primary emphasis was given to the development of a commercial method of FPC manufacture based upon solvent extraction. Based on the earlier work conducted by others, isopropyl alcohol was chosen as the solvent. It was known to be highly effective in the removal of water and lipids from raw fish. It was prepared by a synthetic process which would guarantee its purity and, in addition, isopropyl alcohol was known to be safe, to be reasonably priced, and to be an effective bacteriostat.

Initially the fish used in the manufacture of FPC was red hake. Subsequently, a variety

of fish has been used to produce FPC by isopropyl alcohol extraction and the research has demonstrated that a satisfactory FPC can be produced from a variety of fish.

A modified cross-current batch extraction system was developed first. In this system fish were comminuted and mixed with azeotropic isopropyl alcohol at room temperature with a ratio of solvent to fish of 2:1 by weight. After agitation, the solid and liquid were separated in a centrifuge. The wet solids were then re-slurried with fresh alcohol and extracted continuously at about 70° C. in a system where the extract was continuously drawn off, filtered, evaporated, and the condensed overhead pumped back into the extractor. The solids were then separated from the liquid in a centrifuge. The solids were desolventized in a vacuum oven at 160° F. for 18 to 22 hours.

Subsequently, a system closely approximating a commercial batch countercurrent process was developed. In this process a four-stage countercurrent procedure with an overall ratio of solvent to fish of 2:1 was used. The first stage extraction was performed at room temperature, while the second, third, and fourth stages were performed at 70° C. The solid-liquid slurry from each stage was separated by centrifugation and the final solids were desolventized as in the original process. Theoretically the processing of a large number of batches of fish would be required before this countercurrent system would attain steady state operating conditions, that is, before the composition of the liquid and solids in each stage would not change from batch to batch. However, experience indicated that the system essentially reached steady state conditions after the fourth batch and definitely after the fifth stage.

FPC from a variety of fish has been processed using the aforementioned systems. In Table 1, the proximate composition of FPC produced from a variety of fish is shown. The species of fish that are used in FPC manufacture can affect the chemical composition of the final product. Some fish, such as menhaden, contain a higher proportion of bones to protein than do other fish, such as hake. Thus, FPC made from whole menhaden may contain about 20 percent ash and 78 percent protein, whereas that made from hake may contain 13 percent ash and more than 80 percent protein. Providing the lipids are efficiently extracted during processing, FPC from both fish will contain less than .5 percent lipid.

The variation in ash and protein in FPC's can largely be removed by separating most of the bones from the flesh during processing. This can be accomplished by passing the raw fish through a deboning machine prior to solvent extraction. These machines are available commercially and they efficiently separate the bone and the skin from the flesh. Up to about 90 percent of the whole fish can be recovered in the bone-free fraction. The

Table 1 - Proximate analyses of fish protein concentrate (FPC) prepared by isopropyl alcohol extraction of various species of fish (expressed as percent of sample)

Species of fish used	Crude protein (N x 6.25)	Volatiles	Ash	Lipids
Red hake-FPC	80.9	7.7	13.5	0.18
Atlantic menhaden-FPC	78.5	3.8	19.4	0.18
Atlantic herring-FPC	87.5	5.9	10.8	0.19
Northern anchovy-FPC	80.0	6.1	16.8	0.07
Ocean pout-FPC	86.0	1.5	15.0	0.24
Alewife-FPC	86.0	2.3	15.7	0.09
Moroccan sardines-FPC	79.7	4.4	-	0.21
Red hake-FPC, non-deboned	87.2	1.9	12.8	0.46
Red hake-FPC, deboned	92.2	4.0	5.3	0.14

efficiency of separation varies somewhat between different species of fish. As shown in Table 1, FPC processed from deboned fish contains higher amounts of protein than the non-deboned.

Table 2 shows data on the nutritive value of FPC's produced from a variety of fish. In general, all FPC's have a nutritive quality equal to or higher than that of casein. Also listed in Table 2 is the nutritive value of FPC prepared from deboned fish. From limited results available, it appears that the quality of the protein in FPC prepared from deboned fish is slightly higher than that of FPC made from non-deboned fish.

be attributed to the diet or to the FPC. These studies have shown that FPC prepared by isopropyl alcohol extraction is safe, wholesome, and in addition has high nutritive quality.

Laboratory research is continuing on the use of other solvents and combinations of solvents to extract lipids and water from the whole or partially deboned fish. The purpose is to develop new processes that can produce products with varied characteristics. These products are to be used as nutritional supplements but would have improved functional properties. For example, they might be used in processed meats as both a meat extender and a fat binder.

Table 2 - Nutritive quality of fish protein concentrate (FPC) prepared by isopropyl alcohol extraction of various species of fish

Species of fish used	Average daily weight gain (g)	Average daily food intake (g)	Protein efficiency ratio[a]
Red hake-FPC	5.21 ± 0.13	14.8 ± 0.2	3.19 ± 0.09
Atlantic menhaden-FPC	4.60 ± 0.19	13.9 ± 0.4	3.05 ± 0.06
Atlantic herring-FPC	5.32 ± 0.15	15.0 ± 0.3	3.15 ± 0.05
Northern anchovy-FPC	5.18 ± 0.12	14.6 ± 0.3	3.25 ± 0.03
Ocean pout-FPC	4.68 ± 0.21	13.8 ± 0.5	3.06 ± 0.04
Alewife-FPC	5.28 ± 0.15	15.2 ± 0.2	3.17 ± 0.07
Moroccan sardine-FPC	4.98 ± 0.14	15.7 ± 0.2	2.96 ± 0.05
Red hake-FPC, non-deboned	5.94 ± 0.14	15.1 ± 0.4	3.27 ± 0.04
Red hake-FPC, deboned	5.73 ± 0.37	14.2 ± 0.8	3.36 ± 0.08
Casein	4.35	13.0	3.00

[a] Values adjusted to a casein value of 3.00.

An exhaustive evaluation has been made of FPC prepared from a variety of fish by the isopropyl extraction method. This evaluation included a determination of the physical, chemical, and sensory properties of the FPC's, a determination of the protein quality and of the microbiological and toxicological safety. The final product has no fishy flavor or odor and consists of a fine, free flowing, lightly colored powder. Toxicological studies have been conducted with rats and mice over several generations in which FPC was the sole source of protein. The studies are now nearing completion and the data indicate no untoward results have occurred that can

Biological Methods.--The biological methods of FPC preparation are based on the use of enzymes to convert fish protein into a stable concentrate with desirable properties. The enzyme systems employed may be the natural enzymes in the fish, commercially available enzymes, or enzymes supplied by living cultures of microorganisms. Development of biological processes is being pursued because an enzymatically produced product can have special properties which make it particularly suitable for certain applications. The production costs may also be less since the basic processing equipment may be simple and quite adaptable to shipboard or remote area use.

Numerous methods have been developed for the biological production of FPC. Several methods are referred to in the bibliography published by the Library of Congress. In this paper, only the research conducted by the National Center for Fish Protein Concentrate will be presented.

In-house Research.--The primary objective has been to develop a process for a totally water-soluble product which will offer distinct advantages for use in such foods as soups and beverages. Although processing costs have been considered throughout the work, the major concern has been for improvement of the amino acid pattern and nutritive value of the soluble product. The basic process outline includes enzymatic digestion of a whole fish slurry with control of pH and temperature, screening out of bones and scales, separation of undigested solids by centrifugation and spray drying of a clarified hydrolysate to yield a soluble product consisting of peptides, polypeptides and some free amino acids. An alternate product which is easily dispersible but only partially soluble is prepared by eliminating the centrifugation step.

In early experiments with a specially prepared fish protein substrate, the relative proteolytic activities of 23 commercially available enzyme preparations were compared. Papain, ficin, bromelin, pepsin, and trypsin from two or more manufacturers each and several preparations of bacterial and fungal enzymes were tested. Based on a one-hour hydrolysis at pH 7 and 40° C. used in initial tests, preparations of the enzyme ficin were most active. In a second set of experiments 24-hour digestions were carried out at conditions of pH and temperature considered near optimum for each enzyme preparation. Based on enzyme concentrations required to solubilize 60 percent of the insoluble solids the fungal enzyme Pronase was most effective. Papain, pepsin, and pancreatin showed the most promise when activity per unit cost of enzyme was considered.

Initial hydrolysates of whole fish were prepared from pre-sterilized slurries of red hake (Urophycis chuss) but the soluble products were critically low in tryptophan and the aromatic amino acids. Both yields and amino acid profiles were improved by hydrolyzing raw hake and utilizing the native enzymes in conjunction with added commercial enzyme preparations.

An extended series of 5-liter hydrolysate batches were prepared from raw hake using a variety of enzyme preparations and processing conditions. The results were analyzed and although essential amino acid contents of solubles were improved by elimination of precooking, they were not adequate for good nutritive value. Tryptophan concentrations were low in hydrolysates prepared under acid conditions and histidine recovery was poor in those prepared under neutral to slightly alkaline conditions. Attempts to overcome the problem with a two-stage hydrolysis were not successful.

Experiments with newly acquired alkaline proteases of Bacillus subtilis revealed that fairly good recoveries of both tryptophan and histidine could be obtained in soluble FPCs hydrolyzed at pH 8.5 and above. Hydrolysis with pancreatin above pH 8.5 also gave good yields and better histidine recovery than did earlier runs at pH 8. Pancreatin and the alkaline protease Alcalase* were chosen for evaluation in replicate runs. Both hake and a fatty fish, alewife (Alosa pseudoharengus),

Table 3 - Nutritive quality of hydrolysates produced from red hake and alewife by enzymatic hydrolysis

Enzyme used	Protein efficiency ratio: Actual	Protein efficiency ratio: % of casein
Red Hake		
Pancreatin, 0.50%	2.89 ± 0.07[a]	82.2
Alcalase, 0.35%	2.63 ± 0.10	74.8
Autolysis	2.87 ± 0.07	81.7
Alewife		
Alcalase, 0.5%	3.44 ± 0.06	97.2
Alcalase, 0.3%[b]	3.34 ± 0.07	94.4
Autolysis	3.40 ± 0.08	96.0

[a] Standard error of the mean.

[b] Produced by digestion of presscake. All other samples were produced by digestion of raw fish.

*Supplied by Enzyme Development Corp., New York, and manufactured by Novo Industries, Copenhagen. The use of manufacturers' and trade names throughout this article is for informational purposes only and does not imply endorsement.

were hydrolyzed and chemical analyses, material balances and protein efficiency ratios (PERs) were determined.

Yields of soluble products from hake and alewife were in the range of 12-14 percent of wet fish weight. Partially soluble products were also prepared from both species by autolysis and from alewife presscake by hydrolysis with Alcalase. These products included undigested solids, except bones and scales removed by screening, and were obtained in high yields but residual fat was also high.

The PERs determined by feeding studies with each of the hydrolysates are listed in Table 3. The soluble product from alewife had a PER essentially equal to that of casein, a level that we have not reached with a totally soluble product of red hake. Although the soluble hake products were inferior to casein as a sole source of protein, they were nearly equal to casein as a supplement to wheat flour protein as is shown in Table 4.

Table 4 - Supplement value when added to wheat flour of hydrolysates produced from red hake

	Sample 2%, wheat flour 8% of protein in diet[a]		Sample 4%, wheat flour 6% of protein in diet	
Enzyme used	PER	% of wheat flour	PER	% of wheat flour
Pancreatin	2.17 ± 0.05[b]	171	2.85 ± 0.05	224
Alcalase	2.09 ± 0.07	165	2.74 ± 0.05	216
Autolysis	2.26 ± 0.12	178	2.87 ± 0.08	226
Casein	2.28 ± 0.03	180	3.02 ± 0.07	238

[a] Diets contained 10 percent protein of which the supplements provided 2 or 4 percent and the remaining 6 or 8 percent was supplied by wheat flour.

[b] Standard error of the mean.

Suggested process outlines have been developed for biological processes utilizing raw whole fish and fatty fish press cake. Material balances obtained experimentally were used in conjunction with a newly-developed computer program to estimate production costs for the two types of products. It is estimated that plants processing 200 tons/day of fish costing 1¢ per pound could produce a totally soluble product for less than 19¢ per pound. A plant of similar size could produce a partially soluble product from press cake for about 12¢ per pound. These figures are based on operating costs including amortization, but do not include marketing costs and profit margins.

Contractual Research.--Additional work on biological methods for FPC has been done under contract. At Columbia University, hundreds of microorganisms were screened for lipolytic, proteolytic and organoleptic suitability for fish fermentation. A fungus, Geotrichum candidum, and a yeast, Candida lipolytica, were determined to be most promising for menhaden fermentation. Both microorganisms utilized for lipids and non-protein nitrogen contained in menhaden and effected a reduction in fat content and a net increase in protein content of the ferment while yielding a product with a neutral to pleasant aroma. These results have been reported in a publication by Burkholder et al. (5).

At the Massachusetts Institute of Technology, the solubilization of solvent-extracted FPC by enzymatic hydrolysis has been investigated. Several enzymes were evaluated in batch studies and a continuous system was developed in which an ultra-filtration membrane was used to remove hydrolytic products while retaining the enzyme and insoluble solids for continued reaction. It appears that this approach may not be feasible because of the instability of proteolytic enzymes under suitable reaction conditions. A large continuous system is now being assembled which will employ a relatively inexpensive B. subtilis enzyme and will produce sufficient products for evaluation including PER determinations.

Production

Most large-scale research efforts have involved solvent extraction methods. A wide variety of solvents has been investigated for use in making FPC. These range from non-polar solvents, such as hexane, to very polar solvents, such as methyl alcohol, and from chlorinated hydrocarbons to ketones and esters. It is interesting to note, however, that every commercial or proposed commercial solvent extraction procedure makes use of isopropyl alcohol somewhere in the process.

A description of the major commercial or near commercial operations will serve to illustrate the extensive use of isopropyl alcohol for making FPC.

The FPC Experiment and Demonstration Plant, Aberdeen, Washington.--The Experiment and Demonstration Plant constructed in Aberdeen, Washington, was authorized by the 89th Congress in Public Law 89-701. It is designed to demonstrate the feasibility of commercially producing FPC, by the countercurrent isopropyl alcohol extraction technique developed by the National Marine Fisheries Service. Construction was completed in March 1971. The process used in this plant is that previously described as a four-stage countercurrent extraction with the IPA-water azeotrope. The plant is designed to process 50 tons of raw fish per 24-hour period into $7\frac{1}{2}$ tons of FPC. At present, the plant is designed to process lean varieties of fish and several hundred tons of fish have been processed into large tonnages of acceptable FPC. After demonstrating the process with lean fish, the plant will be modified to process fatty fish. The phases of the process used in the plant are as follows:

Storage.--The fish unloading and storage system is based on the use of refrigerated brine. In this system, 150 tons of fresh fish can be stored at 32° F. in chilled brine. The storage tank is constructed of redwood and contains 12 separate, 750-cubic-foot galvanized, steel-lined compartments. Fish are conveyed to the tanks by a fish pump and belt conveyor system.

Comminution.--The fish are carried from the refrigerated storage in large tote boxes, weighed, and then conveyed to a Rietz disintegrator for comminution. After comminution, the fish can be deboned if such is needed to assure that the final product will meet the 100 ppm fluoride restriction. The comminuted fish are then placed in one of the two slurry tanks.

Extraction.--The fish-IPA mixture contained in the slurry tank is then continuously pumped through the four extractors in which the oil and water are removed. The material moves through the extractors at approximately 30 gallons per minute. During the extraction phase, the solids are removed by a combination shaker screen and pulp press arrangement.

Solvent Recovery.--The liquid portion, called miscella, is then further processed for solvent and by-product recovery. The IPA is purified and recovered by distillation.

Desolventizing.--The solid material, which contains some water and isopropyl alcohol, is dried and desolventized in a series of four Strong-Scott driers.

Milling.--The material is then finely milled and bagged in 50-pound polyethylene-lined bags.

Throughout the process stringent sanitary and safety controls are maintained and monitored by a team of chemists and microbiologists located at the plant site.

The product from the EDP will be packaged in 50-pound quantities and will be made available to industry for research.

Nabisco-Astra Nutritional Development Corporation.--This Corporation, with headquarters in New York City, is a joint venture between the National Biscuit Company, U.S.A., and the Astra Company of Sweden. Astra Nutrition has developed a process for making IPA-FPC and Nabisco is experienced in the production and marketing of protein-enriched food products. The two companies united to form the Nabisco-Astra Nutritional Development Corporation.

The process for making EFP-90 (eviscerated fish protein) as it is called, is a modified IPA process (6).

Fish are cut into segments, washed to remove viscera and blood, and slurried in water and cooked. The cooked material passes through a deboner, a desludging centrifuge, a hot water treatment, and a second centrifuge. From there it enters a continuous extractor where fat is removed by isopropyl

alcohol. On discharge, the IPA is centrifuged to clarify it for return to the solvent recovery system. The extracted fish is passed through a steam-heated agitating desolventizer where any remaining solvent is removed. As a final operation, the material is dried in a steam heated unit, milled to a fine consistency and placed in appropriate containers. The EFP-90 contains between 92-94 percent protein with an IPA residue of less than 100 ppm. At present, herring is used to make EFP-90. Reportedly, the EFP-90 is offered for sale at about 49¢ per pound.

Cardinal Proteins, Ltd.--Cardinal Proteins, Ltd., Nova Scotia, Canada, has constructed a multimillion dollar IPA-FPC plant with a capacity of 200 tons of fish daily. This plant, located in Canso, Nova Scotia, uses the IPA process, as developed in Halifax, Canada. In this system, the initial slurry is acidified with phosphoric acid.

The plant is located next to an established fish processing plant. Cardinal expects to meet one-third of its daily requirement for raw material by fluming cod and haddock trimmings directly from the processing plant. These trimmings currently are being used in fish meal production. However, this material, having been handled under sanitary conditions, is considered superior to fish normally used for making fish meal. Canadian FDD regulations permit the use of sanitary fish trimmings, which is considered economically beneficial and a wise use of the resource. No firm cost figures for IPA-FPC are available at this time.

Societe Nationale Farine Alimentaire Poisson (SONAFAP), Agadir, Morocco.--The Agadir plant uses batch extraction procedures. This plant operated for a few weeks in 1965 and for several months in 1966. About 170 tons of product were produced using hexane and ethyl alcohol, but because of poor odor and color the product was unacceptable. The plant remained idle until about a year ago when operations were once again resumed and an acceptable FPC was made by IPA extraction of sardines (Sardinia pilchardus).

This plant will be used to produce IPA-FPC for acceptability studies in Morocco. No cost figures are available.

Alpine Marine Protein Industries, Inc.--Alpine Marine Protein Industries, Inc., New Bedford, Massachusetts, whose plant was recently sold to another company, used a two-solvent system. The process was based on the VioBin method of extraction of whole fish with ethylene dichloride resulting in a dehydrated and partially defatted material. This material was further extracted with IPA in a continuous countercurrent procedure. The final solids were dried, steam stripped, and milled.

This company, prior to cessation of operations, produced a considerable amount of FPC for use by the U.S. Agency for International Development.

UTILIZATION

To be an effective nutritional supplement, FPC should be supplied in a form that people will readily accept. One means of accomplishing this is to incorporate FPC into foods that people are accustomed to eating. In this respect, we must keep in mind that FPC, by itself, is not a food. Rather it is a supplement that is designed to be added to food products to enhance their nutritive quality. Thus, a major effort has been made to obtain basic information on the use of FPC in various food products.

Sidwell et al. (7) have extensively studied several generic foods to determine suitable levels of incorporation of solvent-extracted FPC as related to alterations in formulations and changes in the characteristics of the resulting food products. Excellent results have been obtained in incorporating FPC into a variety of such products as bread, pasta, and crackers. These studies have shown that the quantity and quality of the protein in these products can be substantially improved by the use of FPC. With most products, little change in the physical and sensory characteristics of the foods occurred when 5 percent FPC was used in the formulation. Foods containing 5 percent FPC were very acceptable, and usually indistinguishable from unsupplemented products. Differences in the organoleptic characteristics of foods were some times found when higher levels were used, especially from certain species of fish. The color of the products was most often altered by the use of higher levels of FPC. In most cases no more than 6 to 8 percent FPC would be recommended from the standpoint of nutrient return per unit of cost. In general, these studies and others have demonstrated that the technological problems related to the incorporation of FPC into food products for

nutritional purposes are not particularly difficult to solve.

Limited food research studies have been carried out with enzymatically produced FPC's. The studies indicated that the FPC's are highly flavored. For most food applications a bland product is desirable and a good soluble protein would command a premium price. With additional development, biological FPC's from whole fish can be of real value for uses where good nutritional quality and special functional properties are required.

MARKETING

The distribution and marketing of foods containing FPC--or any protein supplement--is a difficult and complex problem that involves a host of interrelated factors. Social, economic and cultural considerations must be taken into account. Each particular country or location must be analyzed separately.

United States.--According to a report by Hammonds and Call, the market for FPC's depends upon price-functionality relationships (8). An FPC with functional properties would command a higher price than a non-functional FPC.

Hammonds and Call assumed a price range for FPC of between 28.8 to 53.8¢ per pound of protein. They state that this price range would place FPC costwise between soy flour (12.6 to 16.4¢ per pound of protein) and non-fat dry milk (55.6 to 69.4¢ per pound of protein). Furthermore, since this range is neither clearly lower than that of present protein ingredients, nor clearly higher, the functional characteristics of FPC then becomes crucial in determining the market potential.

The study showed, in summary, that the maximum market potential for protein ingredients is approximately 3.1 billion pounds yearly at the present time. FPC could become an important commodity in this market if the organoleptic, functional, physical, and nutritional characteristics were satisfactory. Obviously, the price would also have to be competitive with other protein ingredients.

Other Countries.--Outside the United States, the competitive market for FPC will be subject to essentially the same type of economic analysis as reported by Hammonds and Call. Some countries, however, have plans to require FPC supplementation in bread and baked goods. This could lead to a sizable market for FPC.

A study was recently conducted in Chile under a contract from the Agency for International Development. The purpose of the study was to analyze the feasibility of commercial production and marketing of FPC. The report of the study noted that there are still some uncertainties regarding the cost of producing FPC. Based on available data, however, it appeared that FPC could be produced profitably for a selling price of 25 to 30¢ per pound. At this price, the report concluded that FPC would be highly competitive with other protein alternatives. At present levels of consumption, about 18,000 metric tons of FPC would be required to fortify bread and pasta in Chile. Although a note of caution was indicated because of several uncertainties, the conclusions of the study were optimistic and indicated that FPC could be produced and marketed successfully.

A recent report concerning the economics of solvent-extracted FPC, however, indicates a less optimistic outlook than the study conducted by AID (9).

SUMMARY

An FPC industry has been started, and plants are now in operation. Isopropyl alcohol is used, in each instance, as at least one of the solvents to remove water and lipids. The isopropyl alcohol extracted-FPC is essentially a "non-functional" product, but has a place on the world market as a high quality nutritional supplement. FPC's with improved functional properties, such as produced biologically or by modified chemical means, are desirable and research is underway for their development.

There is a market for FPC's, but their price and characteristics will govern the extent of usage.

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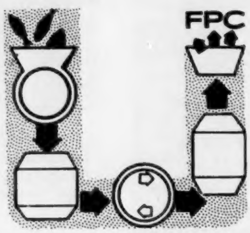


"BECHE-DE-MER" FISHERY FOR TRUK?

Alan J. Beardsley

Beche-de-mer, also known as namako or trepang, is the commercial name of a marine food product held in great esteem by the Chinese. It consists of the dried body-wall of certain species of large Holothurians (sea cucumbers). The term Beche-de-mer is the French rendering of the Portuguese name Bicho-do-mar, which signifies sea slug.

The Truk Lagoon, ranging in diameter from 30 to 40 miles, is a complex coral atoll located on latitude $7^{\circ}25'$ N. and longitude $151^{\circ}45'$ E. in the heart of Micronesia. During the Japanese administration in the early 1940s, as many as one million pounds of Beche-de-mer were exported annually from Truk. Since then there has been no fishery, but informal diver observations indicate large numbers of these animals exist today near the Truk barrier reef. Recently, K. Sachithananthan of FAO and the South Pacific Islands Fisheries Development Agency visited Truk to demonstrate to the Trukese proper collecting and drying techniques for Beche-de-mer. This was done in cooperation with the Marine Resources Development Office in Truk, which provided men, materials, and boats to prepare the animals. Dried samples of Beche-de-mer were then sent to Hong Kong and Singapore to test their market potential.

Fig. 1 - Side view of black teatfish, Actinopyga nobilis. The common name is derived from teatlike projections along sides. A characteristic of this species when irritated or attacked is the expulsion of white sticky tubules.

100 Known Species

There are about 100 known species of sea cucumbers in Truk Lagoon, but few are suitable for Beche-de-mer. The most desirable are the teatfish, Actinopyga nobilis (Figure 1) and prickly redfish, Thelenota aranas. Of lesser commercial value, but also important, is the tigerfish, Holothuria argus (Figure 2). These three species were collected by scuba divers near the Truk barrier reef in water 5 to 40 feet deep. Bait wells in a 36-foot vessel were used to transport the animals alive to the cooking site.

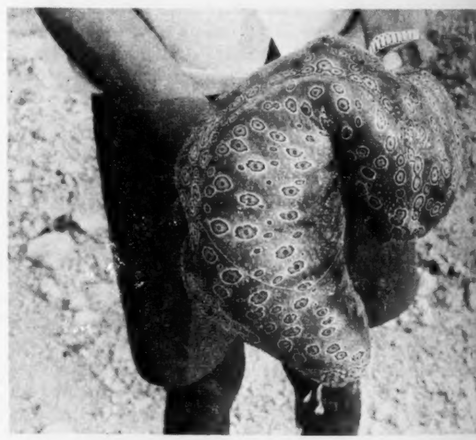


Fig. 2 - Dorsal view of tigerfish, Holothuria argus. Distinctive blue and brown markings characterize this species.

Dr. Beardsley is a fishery biologist with NMFS Exploratory Fishing and Gear Research Base, 2725 Montlake Blvd. E., Seattle, WA 98102. He recently completed a three-month tour of duty in Micronesia at the request of the U.S. Trust Territory of the Pacific Islands government.

Fig. 3 - All sea cucumbers were placed in a large cauldron of boiling water for one hour prior to drying process.

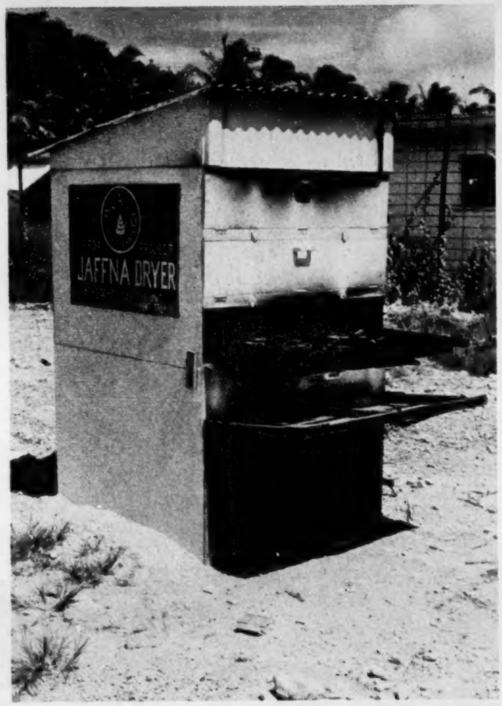


Fig. 5 - The drying house was kept at 80-85° C. for two days to remove moisture from animals. Mangrove wood provided the heat.

Fig. 4 - The animals are cleaned prior to drying and the viscera discarded. These samples are black teatfish and tigerfish.

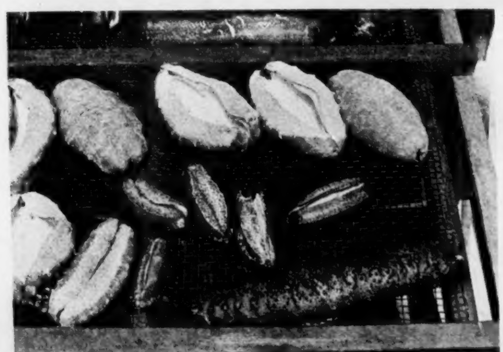


Fig. 6 - Completely dry animals became hard and brittle. Teatfish appear in upper portion of the picture, and a prickly redfish in lower right.

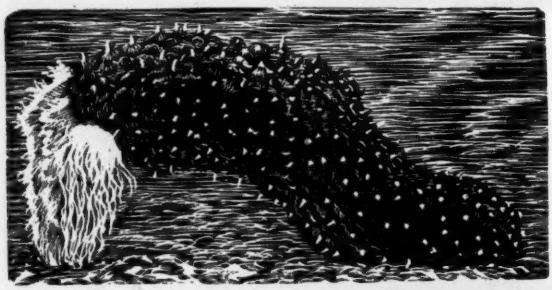
Cooking Procedure

The cooking procedure varies with the species. The teatfish were placed directly into boiling sea water (Figure 3) and cooked for one hour until they were firm and rubber-like. The ventral surface was then slit lengthwise and the viscera removed (Figure 4). The animals were then put in a modified Jaffna Dryer (Figure 5) for 2 days at 80 - 85° C., using mangrove wood as fuel. The flesh became as hard as stone (Figure 6)--hence the name "black stone" or "white stone" in Singapore or Hong Kong markets. Prickly redfish and tigerfish were cleaned by making a small incision in the region of the mouth followed by squeezing out the viscera. After one hour of boiling, the remaining viscera were removed by squeezing, and the animals were dried like teatfish.

Testing Their Market Potential

All animals were graded for size and dryness. Representative samples were packaged in plastic bags, and the sealed bags were air-shipped to markets in Singapore and Hong Kong for evaluation. Similar premium grade samples from other areas in Micronesia brought as high as two dollars per pound, K. Sashithananthan reported.

The potential for establishing an export market for Beche-de-mer from Truk appears promising, but more work needs to be done before a commercial fishery can be established. The size of the resource must be determined so that local businessmen can estimate the magnitude of the processing plant needed. A packaging technique for maintaining the dryness of the animals is also desirable because the high humidity in Truk rapidly hydrates the dried animals. These problems can be rapidly overcome if the animals are abundant and command a high market price.



Sea Cucumber

SWEET 'N' SOUR CINDERELLA SEAFOOD

Heard any good fish stories lately? Well, here's one that's true, and it concerns a Cinderella from the sea with a real fishy success story. Ocean perch, among the most plentiful of fishes, were unloved and rejected for years. One day in the mid 1930s, however, a lowly fish cutter (not a prince) came along and found quite by chance that these unappreciated fish were in reality quite special. He discovered that ocean perch yield small, white fillets very similar in taste and texture to those from the popular fresh-water perch. The fishing industry, ever alert to new and better resources, began experimenting with filleting and freezing ocean perch and soon were on their way to a new "Golden Era of Fishing." Ocean perch are now among the most used and appreciated of fish and are readily available, filleted, packaged, and frozen, at seafood counters across the United States. There are usually about 8 fillets in a one-pound package. Ocean perch are excellent food fish and the fillets are entirely edible, have a delicate flavor and high nutritional value, are easy and attractive to serve, and are moderate in price.

Ocean perch fillets are great eating whether prepared in a batter for fish and chips or served with tartar sauce in a toasted bun. They are outstanding, however, in Sweet 'n' Sour Ocean Perch, a favorite recipe of a talented home economist of the National Marine Fisheries Service. This easy-do recipe is a culinary journey into excellence--but so easy on the budget! The tender fillets are lightly browned before being enhanced with the sauce and cooked until flaky. The sauce, a zippy sweet-sour mixture, is flavor highlighted with celery, onion, garlic, parsley, and dill weed and has texture interest with the addition of crisp bacon bits. Treat your family to Sweet 'n' Sour Ocean Perch soon--but be sure to prepare plenty; this entree will have them calling for seconds.

SWEET 'N' SOUR OCEAN PERCH

- 2 pounds ocean perch fillets or other small fish fillets, fresh or frozen
- 2 tablespoons butter or margarine
- 1 teaspoon salt
- 4 slices bacon, cut into $\frac{1}{2}$ inch squares
- $\frac{1}{2}$ cup chopped onion
- $\frac{1}{2}$ cup thinly sliced celery
- $\frac{1}{4}$ teaspoon minced garlic (optional)
- $1\frac{1}{2}$ tablespoons flour
- $1\frac{1}{2}$ tablespoons sugar
- $\frac{1}{8}$ teaspoon pepper
- $\frac{3}{4}$ cup water
- $\frac{1}{4}$ cup tarragon or cider vinegar
- 2 tablespoons chopped parsley
- $\frac{1}{2}$ teaspoon dry dill weed

Thaw frozen fish. Melt butter or margarine in large (12-inch) frypan. Arrange fillets, skin side down, in frypan overlapping fillets slightly, if necessary. Sprinkle $\frac{1}{2}$ teaspoon salt over fillets. Cook over moderate heat until lightly browned on underside, 8 to 10 minutes. While fish is cooking, fry bacon until crisp. Remove bacon bits and set aside. Add onion, celery, and garlic to bacon drippings and cook slowly until onion is tender, not brown. Combine and mix flour, sugar, remaining $\frac{1}{2}$ teaspoon salt, and pepper. Stir in water and vinegar and mix until smooth. Pour over onion-celery mixture; cook, stirring constantly, until thickened. Stir in parsley. Spoon hot sauce over fillets and sprinkle with bacon pieces. Cook over low heat about 5 minutes or until fish flakes easily when tested with a fork. Makes 6 servings.

(National Marketing Services Office, NMFS, U.S. Dept. of Commerce, 100 East Ohio Street, Room 526, Chicago, Ill. 60611.)

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BACK COVER: Sport fishing in Gulf Stream off Chincoteague, Virginia.
(Rex Gary Schmidt)